NATIONAL PETROLEUM RESERVE IN ALASKA

GEOLOGICAL REPORT

U. S. NAVY

SOUTH SIMPSON NO. 1

HUSKY OIL NPR OPERATIONS, INC.
Prepared by: Ronald G. Brockway

For the

U. S. GEOLOGICAL SURVEY
Office of the National Petroleum Reserve in Alaska
Department of the Interior
JUNE 1983

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INTRODUCTION

The South Simpson No. 1 is located approximately 60 miles southeast of Barrow, Alaska, in protracted Section 22, T17N, R12W, Umiat Meridian, Alaska (Figures 1 & 2). Drilling below conductor casing at 95 feet began on March 9, 1977 and was terminated on April 18, 1977 at a driller's depth of 8,795 feet. The rig was released April 30, 1977. A suite of strata from Cretaceous to Mississippian ages were penetrated with the well ending in the pre-Mississippian argillite.

Hydrocarbon shows were limited to Cretaceous and Jurassic age rocks, in which three drill-stem tests were performed.

A total of 45 sidewall cores were shot with a recovery of 38. No conventional cores were taken.

PRE-DRILLING PROGNOSIS

The well was drilled to test two possible stratigraphic traps, one from a possible truncation of a Jurassic sandstone by the pre-Cretaceous unconformity and subsequent deposition of the "Pebble Shale" and the other from an updip pinchout of the Sadlerochit Group onto the Barrow Arch. A small structural closure was also postulated from seismic data in the Okpikruak Formation ("Pebble Shale"). A pinchout of the Lisburne Group was considered a slight possibility for hydrocarbon traps although seismic information indicated that the pinchout was probably south of the South Simpson No. 1 location.

POST-DRILLING SUMMARY

Drilling of the South Simpson No. 1 has revealed that the expected pinchout of the Sadlerochit Group does not occur at this point. A thickness of 347 feet was present and no hydrocarbon shows were observed. Porosities in the Ivishak Formation of the Sadlerochit Group were computed to be poor to fair and water filled.

The other primary objective, the Simpson sandstone of the Kingak Formation (Jurassic), contained some gas and was tested through perforations at 6522-6568'. An estimated 75,000 CFGPD and 1,215 feet of muddy salt water were recovered. Some component of the sandstone has greatly affected the electrical logs resulting in very high densities and Neutron log porosities. A possible solution for this could be the presence of daphnite or limonite (Appendix D). Porosities appear to be fair to good, but the sandstone is predominantly thin bedded and has siltstone and shale interbeds. It does not appear that the pre-Cretaceous unconformity truncated the sandstone, or if it did, only a small portion of the upper part of the sandstone is missing.

Hydrocarbon shows, mainly gas, were present in the lower Torok Formation and two zones were tested through perforations at 6183-6251' and 5807-5946'. Only mud with a trace of gas was recovered.

In summary, the drilling of the well confirmed the presence of several potential reservoirs, mainly the Ivishak Formation, Sag River Sandstone, Simpson sandstone and Torok Formation sandstones.

The presence of hydrocarbon shows in the Torok and Kingak (Simpson sandstone) Formations indicates these rocks may be potential producers updip, north or northwest of South Simpson No. 1. Pinchouts of the Sag River Sandstone and Ivishak Formation of the Sadlerochit Group, also in a north to northwest direction, are additional possibilities for hydrocarbon accumulations.

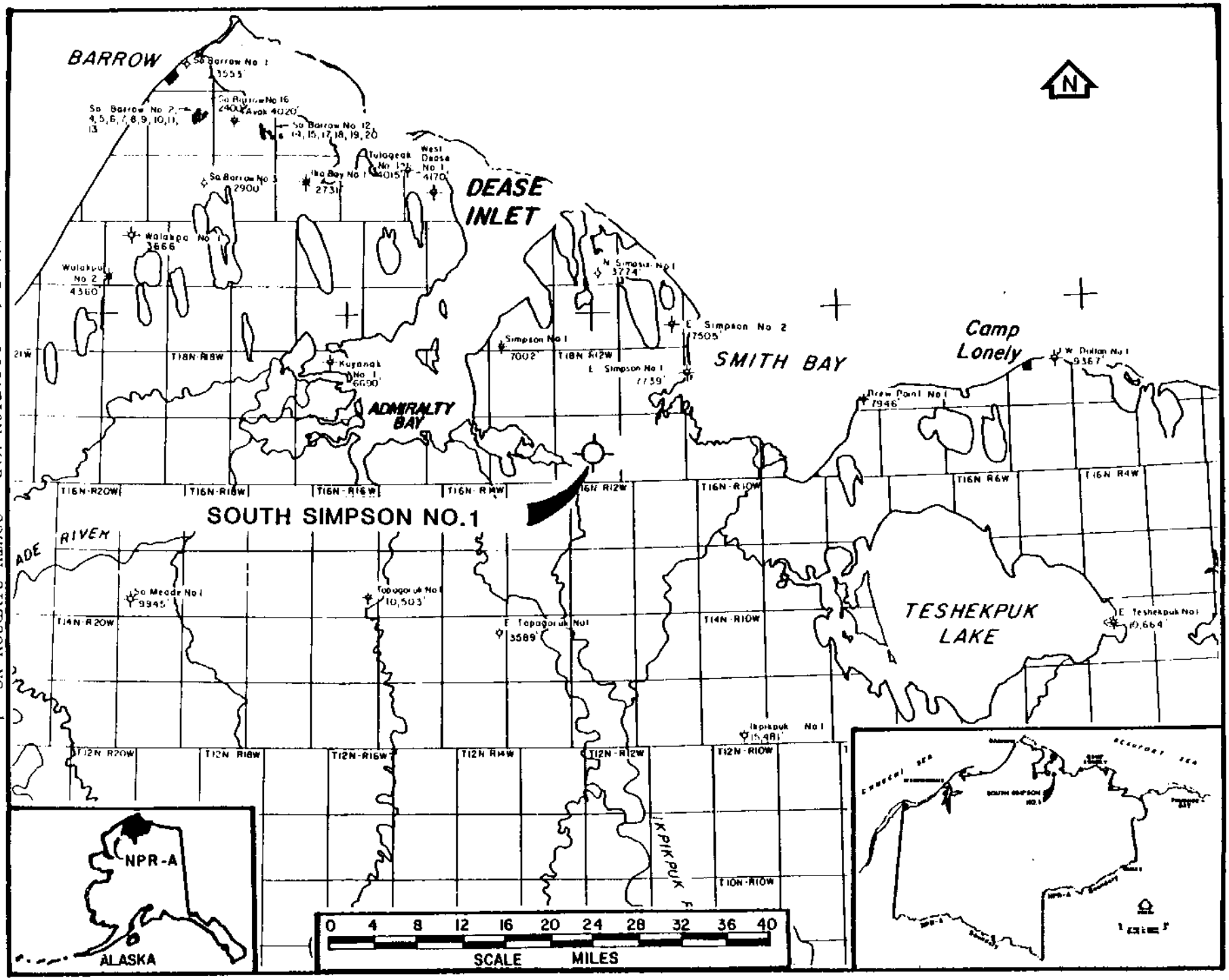
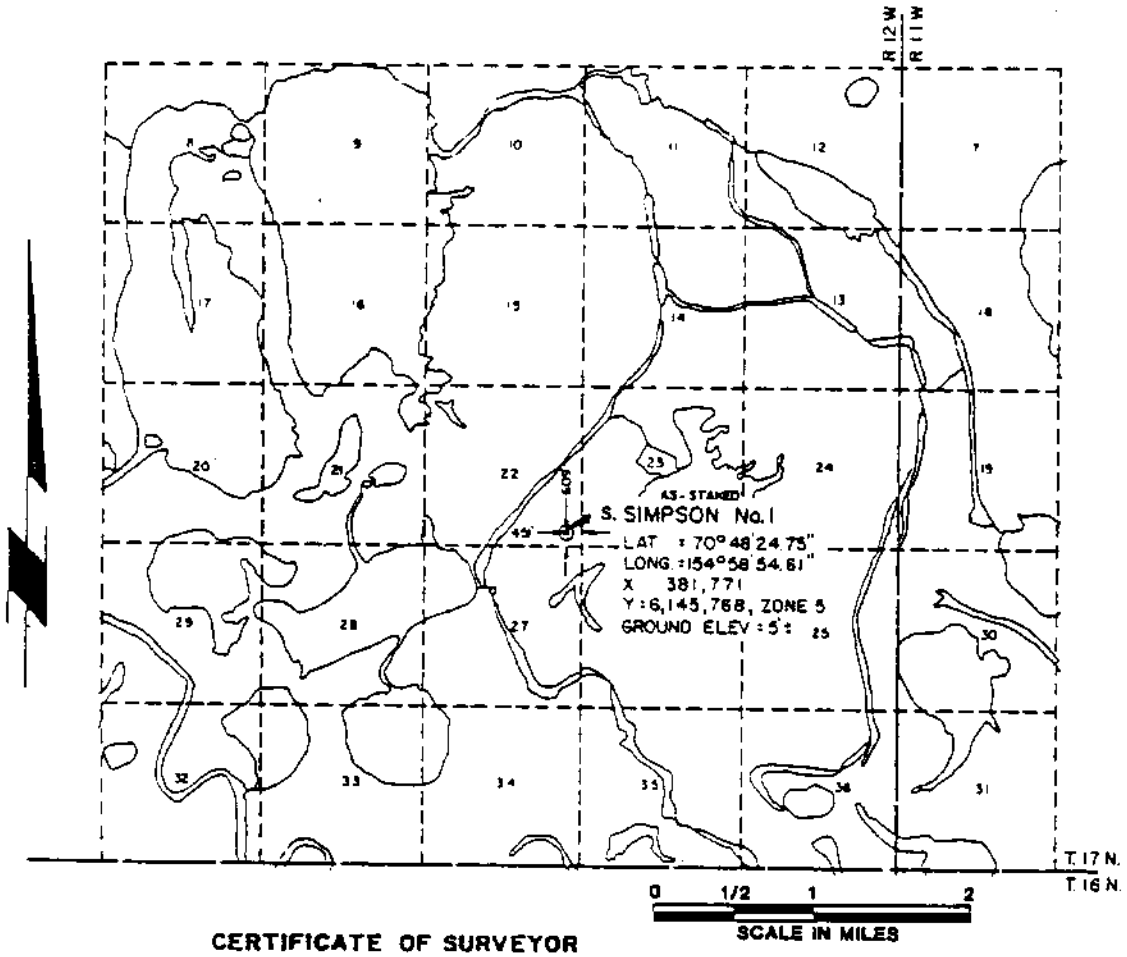


FIGURE 1 - LOCATION MAP - SOUTH SIMPSON NO. 1



CERTIFICATE OF SURVEYOR

I hereby certify that I am properly registered and licensed to practice land surveying in the State of Alaska and that this plat represents a location survey made by me or under my supervision, and that all dimensions and other details are correct.

STATE OF ALASKA
49TH
Andrew F. Potts
NO. 3514-S
REGISTERED PROFESSIONAL LAND SURVEYOR

7-22-76
Date

Andrew F. Potts
SURVEYOR

C J R

AS-STAKED
S. SIMPSON No. 1
Located in
SE 1/4 PROTRACTED SEC 22, T.17 N., R.12 W., UMIAT MERIDIAN, AK
Surveyed for
HUSKY OIL
N.P.R. OPERATIONS INC.
Surveyed by
F.M. LINDSEY & ASSOC.
LAND & HYDROGRAPHIC SURVEYORS
2502 West Northern Lights Boulevard Box
Anchorage

FIGURE 2 - SURVEYOR'S CERTIFICATE - SOUTH SIMPSON No. 1

WELLSITE GEOLOGIST'S REPORT
BY: RONALD G. BROCKWAY

SUMMARY

The South Simpson No. 1 is located in the SE 1/4 of protracted Section 22, T17N, R12W, Umiat Meridian, Alaska in the northcentral portion of Naval Petroleum Reserve No. 4, subsequently transferred to the Department of the Interior, June 1, 1977 and renamed National Petroleum Reserve in Alaska (NPRA). The well is situated approximately 60 miles southeast of Barrow, Alaska. The well was drilled from a 5-foot thick sand and gravel pad constructed on flat tundra with many shallow lakes. Two of these lakes were used; one as a source of water for the drill site and the other as a runway for support aircraft.

Drilling below conductor casing (95') began on March 9, 1977, and the well was drilled to a depth of 510 feet where 20" casing was set at a depth of 495 feet. After setting casing and rigging up, drilling was resumed on March 14, 1977, and the well was drilled to 2,215 feet on March 16. Lost circulation occurred while preparing the hole for logging and casing. Sixteen-inch casing was set at 2,175 feet. Drilling resumed on March 22 with rates of penetration averaging from 0.5 minutes to 1.0 minute per foot. Lost circulation was again encountered at 5,279 feet and 5,965 feet. Rates of penetration slowed to an average of 1.5 minutes to 2.0 minutes per foot in the interval 5500-6750', then to approximately 5 minutes per foot from 6,750 feet to 7,209 feet. Lost circulation problems occurred again at 7,020 feet.

After logging and setting 10-3/4" casing at 7,206 feet, drilling continued on April 9 at a rate of 2 minutes per foot to 7,700 feet. Below 7700' to 8795' (total depth) rates were 5 to 10 minutes per foot. The Sag River Sandstone was encountered at 7,470 feet, the Sadlerochit Group at 8,200 feet, and the Argillite at 8,741 feet. Total depth (8,795 feet - driller) was reached on April 18. No conventional coring was performed on this well.

April 19, 20, and 21 were spent logging, sidewall coring, taking velocity surveys and plugging back in preparation for taking drill-stem tests. Three tests were performed with negative results through perforations at 6522-6568', 6183-6241', and 5807-5946' (Appendix E). A small amount of gas, estimated 75,000 CFPD, was recovered from Drill-Stem Test No. 1 (perforations 6522-6568'). Final testing was finished on April 25 and preparations for abandoning the well and rigging down began on April 26, 1977. The rig was released on April 30, 1977.

STRUCTURAL INFORMATION

The South Simpson No. 1 well was drilled on the southern flank of the eastward plunging Barrow Arch, which extends from Barrow, Alaska to the Prudhoe Bay area in northcentral Alaska. The well was drilled to explore a possible small structural closure and possible stratigraphic traps in a Jurassic sand and the Sadlerochit Group.

Two wells were used for correlation of the South Simpson No. 1: the U. S. Navy - #1 Topagoruk, Section 25, T15N, R16W, Umiat Meridian; and the U. S. Navy - #1 Simpson S/2, Section 32, T19N, R13W, Umiat Meridian. Although all three wells begin in Nanushuk Group rocks, it was found that South Simpson No. 1 was 1,188 feet structurally higher than the #1 Topagoruk and 1,305 feet lower than the #1 Simpson at the top of the Sag River Sandstone. The top of the Argillite was 2,206 feet lower than the #1 Simpson. Argillite was not penetrated in the #1 Topagoruk.

WIRELINE TOPS

	Driller's Depth (Below Kelly Bushing	Subsea Depth
CRETACEOUS		
Nanushuk Group (undivided)	510' Samples start	-485'
Torok Formation	1777'	-1752'
"Pebble Shale"	6335'	-6310'
JURASSIC		
Kingak Formation	6523'	-6498'
TRIASSIC		
Sag River Sandstone	7470'	-7445'
Shublik Formation	7675'	-7650'
TRIASSIC-PERMIAN		
Sadlerochit Group		
Ivishak Formation	8200'	-8175'
MISSISSIPPIAN		
Endicott Group	8547'	-8522'
PRE-MISSISSIPPIAN		
Argillite	8741'	-8716'
TOTAL DEPTH	8795' (Driller)	-8770'

STRATIGRAPHY

CRETACEOUS

Nanushuk Group (undivided): 510-1777'

The Nanushuk Group (undivided) is composed of a series of interbedded sandstones, siltstones and claystones with some coal and marlstone beds.

Sandstones occupy approximately 50% of the interval and occur as thin laminations to units 85' thick. The thicker units usually have thin shale and siltstone interbeds. They are gray to "salt and pepper" and generally very fine to medium grained. Most have poor visible porosity.

Hydrocarbon shows were limited to slight staining and fluorescence and rare small gas kicks. Background gas rose from 25 units to 90 units at 1115' and generally were from 50 to 100 units downward into the upper Torok Formation. A maximum of 200 units of gas was recorded from 1185-1190'. None of the shows were considered good enough to test.

Interbedded with the sandstones are soft light gray (sometimes medium gray) siltstones and claystones. Thin coal stringers are scattered throughout the entire interval, but are most common above 730'.

Depositional environment for the Nanushuk was probably Middle Neritic to Upper Bathyal. Paleontological data by Anderson, Warren & Associates, Inc. have placed the interval 510-3780' into an Early Cretaceous (Albian), (Nanushuk-Upper Torok) age. This is also confirmed by their palynological data.

Torok Formation: 1777-6335'

The contact of the Nanushuk Group and Torok Formation is gradational in this (and other) well and for continuity with other reports has been picked at 1777', the base of the thick sandstone sequence of the lower Nanushuk Group.

Medium to dark gray, carbonaceous shales are the major component of the Torok Formation with some light to medium gray claystones observed in the upper 2,200 feet. Siltstones are present throughout the formation and occur mainly as thin beds and laminations. Thicker zones (maximum 100') are present above 3900'.

Sandstones of the Torok are primarily confined to the upper 1300' and lower 1000'. Those of the upper interval are scattered, but contain the thicker units (maximum 50'). The lower 1000' is characterized by thin interbedded sandstones and shales with a few siltstones. Rarely do the sandstones of the lower unit attain thicknesses of 20' and are generally less than 10'. Sandstones of the Torok are primarily light to medium gray, very fine grained, subangular, carbonaceous and silty. A few fine grained beds are present. Nearly all sandstones exhibit varying amounts of visible porosity.

Hydrocarbon shows, predominantly gas, were recorded from the sandstones throughout the lower 1000'. Some fluorescence and staining were observed in the interval 6170-6310'. Individual gas shows varied from approximately 400 units to a maximum of 1,280 units at 5990-6000'.

Drill-stem tests were performed over the perforated intervals of 6183-6241' (Drill-Stem Test No. 2) and 5807-5946' (Drill-Stem Test No. 3). Only mud with a trace of gas was recovered (Appendix E).

Lost circulation zones were encountered at 5279' and 5965'. Possibly fracturing or faulting has occurred at these points as there appears to be anomalies present on the dipmeter log at the two zones. Other electrical logs indicate that something has definitely happened at 5945'. It is the opinion of this author that this is a fault zone and may have some relationship to the 1,280 unit gas reading at 5990-6000'. Possibly the faults are a transportation median for gases generated in the shales below. Other gas readings of 448-480 units were recorded from 5945-5965'.

An Early Cretaceous (Aptian to Early Albian) age has been assigned by biostratigraphic data to the interval 3780' to 6,340' (Anderson, Warren & Associates, Inc.). Deposition of the Torok Formation sediments occurred in an open marine environment.

"Pebble Shale": 6335-6523'

The top of the "Pebble Shale" has been picked at the top of a radioactive zone on the electrical logs. This is also confirmed by a change in the shale; at this point, the shales become very dark gray to black and contain floating rounded quartz grains which are typical of the "Pebble Shale".

Anderson, Warren & Associates, Inc. have given the interval 6340-6520' a probable Neocomian age.

JURASSIC

Kingak Formation: 6523-7470'

The Kingak Formation is comprised primarily of dark gray to dark gray-brown shales and gray to brownish-gray siltstones. Both are glauconitic in part. Sandstones are minor with the exception of a thick sandstone sequence at the top (6523-6697').

This sandstone, informally called the "Simpson sandstone", is light gray, gray-green and gray-brown, very fine grained and contains glauconite pellets measuring up to 1.5 millimeters. Some thin beds in the sequence also have a glauconitic matrix. Interbedded with the sandstone are thin siltstones and shales.

Some component of the sandstone has affected the electric logs in the zone 6520-6590'. The density log records very high densities and in one zone is greater than 3.0 grams per cubic centimeter. A high porosity of 45% to 60% is indicated on the neutron log. Daphnite and Limonite were the only two minerals found which could qualify to give these types of responses (see Schlumberger letter, Appendix D). It is possible that the high densities in this zone have also affected the computations for porosities.

Gas readings to a maximum of 1,536 units were recorded in the interval 6520' to 6700'. Porosities ranging from 9.5% to 30% were computed from porous zones on the electric logs over the interval 6526-6570'. The accuracy of the porosity calculations is questionable; visual examination of the samples indicated very low porosity.

A drill-stem test (No. 1) taken over a perforated interval 6522-6568' recovered an estimated 75,000 CFGPD and 1215' of muddy salt water.

A probable Early Jurassic age has been assigned by Anderson, Warren & Associates, Inc. to the interval 6520-7660', which includes the underlying Sag River Sandstone. The rocks of this section were probably deposited in a fluctuating turbid Middle to Outer Neritic environment.

TRIASSIC

Sag River Sandstone: 7470-7675'

Although an Early Jurassic age (paleontology) has been assigned to the Sag River Sandstone in this well, the author has placed it in the Triassic to conform with other wells in NPRA where it has been given a Triassic age. The 205 foot section of the Sag River Sandstone is composed of very light gray, very fine grained, glauconitic sandstone with a few shale interbeds near the base. No hydrocarbon shows were recorded except in the 7480-7490' sample where a very slight pale yellow crush cut was observed.

Porosities, as computed from the electrical logs, varied from 11% to 18% for an average of 15.2%. All zones were water wet (Appendix C).

Shublik Formation: 7675-8200'

The Shublik Formation is a sequence of interbedded rocks varying from shales to limestones and possibly could be divided into three units; an upper and lower limy unit and middle sandstone, shale, and siltstone unit. The upper unit, approximately 37 feet thick, has very fossiliferous "dirty" limestones which are in part coquina. This zone also contains a brown sandstone at the top which is partly iron stained and a light brown mottled claystone which appears to be, in part, a caliche and has some iron staining. This could be a weathered zone marking the top of the Shublik Formation.

Interbedded calcareous, fossiliferous shales, siltstones and sandstones are present in the middle unit (7712-8068') and occupy the major portion of the formation. Rare traces of dead and tarry hydrocarbon residue were present and appear to be associated with calcite-filled fractures or veins.

The lower unit (8068-8200'), also a sequence of interbedded strata as in the middle unit, has, in addition, limestone units which obtain thicknesses of 15'. These limestones are much like those of the upper unit; i.e., very fossiliferous and partly coquina, although the color becomes more gray. An added component which separates this zone from the others, is the presence of phosphate pellets which are common to the lower portion of the Shublik.

Two small gas kicks were recorded at 8145' (170 units) and 8170' (240 units) in the lower unit; a very slight staining and very faint cut were observed in the 8160-8170' sample.

Anderson, Warren & Associates, Inc. have dated the interval 7660-8200' as Triassic (paleontology) and 7690-8410' as Late Triassic (Norian-Rhaetion) by palynology.

TRIASSIC-PERMIAN

Sadlerochit Group

Ivishak Formation: 8200-8547'

One of the two primary objectives in the South Simpson No. 1 was the Ivishak Formation. It is characterized by conglomerates, conglomeratic sandstones and carbonaceous sandstones with coal partings and thin dark gray shale interbeds. Some red shales were observed in the zone 8260-8300'. Tripolitic chert grains and pebbles are common above 8450'.

Somewhat surprising is the presence of carbonaceous quartzitic sandstones with thin beds and chips of coal in the lower part of the Ivishak. These type sandstones are not common to the Ivishak and more closely resemble Mississippian age sandstones (Kekiktuk Formation) present in the Inigok Test Well No. 1 (Sec. 34, T8N, R5W) and some wells east of NPRA. Since the depositional environments of the Sadlerochit Group have been depicted to be nonmarine to Inner Neritic (Anderson, Warren & Associates, Inc), the presence of coals may represent a deltaic sequence. Anderson, Warren & Associates, Inc. give a Triassic-Permian age to the interval 8200-8590' but note that Echooka Formation type rocks are not present.

Computed porosities of the Ivishak were poor to fair (Appendix C). The formation was void of any hydrocarbons and water saturated. The base of the Ivishak has been picked at 8547' where there is a change in color from the dark shales interbedded with the sandstones to a red silty shale and red to pink sandstones. Tetra Tech, Inc., in reports dated October 24, 1980 and March 31, 1982*, has placed a 38' interval (8550-8588') into the Kavik Member of the Ivishak Formation. It is the opinion of this author that these redbeds are more typical of Mississippian age rocks than of the Kavik Member, therefore, they have been included in the Endicott Group.

The Kavik Member and Echooka Formation of the Sadlerochit Group are missing in this well; the Kavik, probably due to non-deposition and the Echooka by either non-deposition or erosion by a local unconformity.

* (Tetra Tech, Inc. reports are available from the National Oceanic and Atmospheric Administration, Boulder, Colorado.)

MISSISSIPPIAN

Endicott Group: 8547-8741'

The rocks in the Endicott Group are composed of red calcareous shales with limestone nodules, red and pink limestones, varicolored conglomerates and conglomeratic sandstones, and some red siltstones.

Biostratigraphic evidence is not decisive, but Anderson, Warren & Associates, Inc. state the interval 8590-8740' is probably Carboniferous to Permian in age.

PRE-MISSISSIPPIAN

Argillite: 8741-8795' Total Depth

The top of the Argillite section has been picked on the occurrence of very dark gray to black shales with quartz veinlets and quartz filled fractures. Coal stringers and inclusions were noted in the upper 20 feet and possibly this zone may be a remnant of the Kekiktuk Formation, but coals have also been cited in Devonian age rocks.

Although readings on the dipmeter are somewhat scattered, there appears to be a slight increase in dip below 8770'. In the interval 8740-8770', it appears that the dip is 7-8°, increasing to 12-14° below 8770'. Generally, steeper dips are encountered in the Argillite.

No foraminifera were found below 8740'. Densospores below 8770' indicate a possible Carboniferous (Mississippian) age. Anderson, Warren & Associates, Inc. note that "...these densospores had been observed reworked throughout the well in much less frequencies. The fact that these spores may also be reworked at the bottom of the well cannot be ruled out."

CONCLUSIONS

Final evaluation of the data from the South Simpson No. 1 indicated that the well did not have commercial quantities of hydrocarbons. Plugs were set and the well abandoned.

The Simpson sandstone section of the Kingak Formation, which had an estimated 75,000 CFGPD, was not present in the Simpson No. 1, approximately 12 miles northwest. Whether the pinchout of this sand would be worthy of more exploration is questionable as the sandstones in the South Simpson well are generally thin bedded, "dirty" and interbedded with siltstones and shales.

Although the Sag River Sandstone and Ivishak Formation were barren of hydrocarbons, it is possible that they may form a trap in an updip direction to the north and northwest. It should be noted that the Sadlerochit Group and Mississippian age rocks are missing in the Simpson No. 1 well.

PERTINENT DATA AND APPENDICES

SUMMARY OF PERTINENT DATA*

WELL NAME:	South Simpson No. 1
API NO.:	50-279-20001
OPERATOR:	Husky Oil NPR Operations, Inc.
LOCATION:	609' FSL, 451' FEL SE 1/4, protracted Section 22, T17N, R12W, Umiat Meridian, Alaska
COORDINATES:	Latitude: 70°48'24.75"N Longitude: 154°58'54.61"W X = 381,771 Y = 6,145,768 Zone 5
ELEVATION:	25 feet, Kelly Bushing; 5'±, ground
CASING:	30" @ 95' 20" @ 495' 16" @ 2175' 10-3/4" @ 7206' Driller (7212' Schlumberger)
DATE SPUDDED:	March 9, 1977
FINAL TOTAL DEPTH:	8795' Driller; 8807' Schlumberger
DATE REACHED TOTAL DEPTH:	April 18, 1977
RIG RELEASED:	April 30, 1977

LOGGING RECORD (Open Hole):

DIL/SP/TTI	496-2180' 2175-7200' 7212-8799'
BHCS/GR/TTI	496-2180' 2176-7201' 7212-8799'
FDC/CNL/GR/Caliper	2175-7204' 7212-8806'
HDT Dipmeter	2176-7200' 7212-8804'
CBL/VDL/GR	5500-7206'
Check Shot Velocity Survey	1000-8805'
Mud Log	510-8795'
Computed Logs	
Arrow Plot (Dipmeter)	2192-7193' 7216-8794'
Saraband	2180-8800'

SIDEWALL CORES:	Run No. 1 - 27 shot, 25 recovered. Run No. 2 - 18 shot, 13 recovered.
CONVENTIONAL CORES:	None
DRILL-STEM TESTS:	DST No. 1, perf. 6522-6568 - 4 per foot Recovered estimated 75,000 CFGPD, 1215' muddy salt water plus 500' water cushion. DST No. 2 - perf. 6183-6202', 6211-6220', 6231-6241', 4 per foot. Recovered 705' (12.5 bbls.) watery mud plus 500' water cushion. DST No. 3 - perf. 5807-5816', 5846-5856, 5903-5946', 4 per foot. Recovered 16 barrels fluid (11.9 barrels water cushion and 4.1 barrels mud).
STATUS:	Dry and abandoned.
WELLSITE GEOLOGIST:	R. G. Brockway
LOG ANALYST:	Armour Kane
DRILLING CONTRACTOR:	Nabors Alaska Drilling, Inc.
MUDLOGGERS:	Borst & Giddens Logging Service
BIOSTRATIGRAPHIC ANALYSIS:	Anderson, Warren & Associates, Inc.

* Copies and/or reproducibles of all geological data are available from:

National Oceanic and Atmospheric Administration
EDIS/NGSDC (D62)
325 Broadway
Boulder, CO 80303

SOUTH SIMPSON NO. 1
DRILL CUTTINGS AND DESCRIPTIONS
BY: R. G. BROCKWAY

NOTE: Samples in this appendix have not been adjusted to mechanical control. No conventional cores were taken. Sidewall core descriptions are given in the tail of composite lithology log.

DRILLED DEPTH (FEET BELOW KELLY BUSHING)	
0- 510	No recovery.
510- 540	Claystone: 95%, medium gray, slightly carbonaceous, occasional coal chips, siderite nodules, Siderite stringers: 5%, brown, hard.
540- 570	Very poor sample, predominantly drilling mud, trace of Sandstone: light gray, fine grained, subangular, slightly carbonaceous, apparently friable, rare coal chips, trace of siderite, probably clayey section.
570- 600	Coal: 90%, black, lignitic to subbituminous, interbedded Shale: 10%, brown-black, very carbonaceous, siderite inclusions, slightly pyritic; trace of claystone.
600- 630	Shale: 50%, as above; Claystone: 30%, light to medium gray, slightly carbonaceous, coal partings, Coal: 20%, as above.
630- 660	Siltstone: 75%, light gray to gray-brown, clayey, carbonaceous, with Sandstone: 25%, light gray, fine grained, subangular, slightly salt and pepper, carbonaceous, very friable, white altered grains, feldspar, pink and green grains, and trace of Siderite: light brown, buff, coal stringers,
660- 690	Siltstone: 50%, light gray, slightly micaceous, soft, clayey, with Claystone: 30%, light gray, silty, slightly sandy, siltstone stringers, and Sandstone: 20%, gray, gray-brown, fine grained, subangular, silty, carbonaceous, calcareous, trace of siltstone.
690- 720	Sandstone: 100%, as above, a few stringers with good porosity, partly stained, slightly calcareous, dull gold fluorescence, no cut, trace of calcite-filled fractures.
720- 750	Sandstone: 70%, as above, becoming very fine grained and more calcareous at 730', dull yellow fluorescence,

very slight dull yellow cut, with Coal: 15%, black, lignite, siderite stringers, and Marlstone: 15%, medium gray, hard, slightly silty.

750- 780 Sandstone: gray, gray-brown, silty, carbonaceous, very fine to fine grained, subangular, medium sorted, sideritic, pyritic, trace of calcite-filled fractures, dull gold to bright yellow, spotty fluorescence, stringers of Shale: dark brown-gray, very carbonaceous, and Coal: lignitic.

780- 810 Sandstone: 45%, as above, with increasing siltstone, fluorescence and cut as above; Claystone: 10%, light gray, silty, slightly carbonaceous; with interbedded Siltstone: 45%, light to dark gray, argillaceous, slightly sideritic.

810- 840 Sandstone: 50%, gray, light gray, very fine with fine grained stringers, subangular, carbonaceous, calcareous, slightly sideritic and pyritic, slight porosity in fine grained stringers; Siltstone: 35%, gray to dark gray, clayey, carbonaceous; Claystone: 15%, light gray, carbonaceous, silty.

840- 870 Sandstone: 50%, gray-brown, gray, partly loose, subangular, poorly sorted, silty, carbonaceous, calcareous, siderite inclusions, slightly pyritic, spotty dull gold fluorescence, no cut; Marlstone: 35%, dark gray, slightly brown, very argillaceous, slightly silty, hard, trace of calcite-filled fractures, dark gray-brown calcareous shale and siltstone, 15%.

870- 900 Sandstone: 60%, gray-brown to slightly salt and pepper, very fine to medium grained, calcareous, carbonaceous, siderite nodules, slightly pyritic, very tight to slightly porous, trace of calcite-filled fractures, spotty dull gold fluorescence; Marlstone: 25%, gray, slightly silty; Shale: 15%, gray to brown, calcareous, slightly silty.

900- 930 Sandstone: 70%, gray to salt and pepper, fine to medium grained, fine grained, hard and calcareous, medium grained, loose, subangular, medium sorted, carbonaceous, shell fragments, slightly pyritic, probable porosity in medium grained sand; Marlstone: 20%, gray, as above; Claystone: 10%, light gray, silty, siderite nodules.

930- 960 Lost circulation; sample 99% lost circulation material, trace of light gray, gray, very fine grained, subangular, silty, calcareous sandstone (cavings ?).

960- 990 Sandstone: 60%, gray, very fine grained, subangular, medium sorted, silty, carbonaceous, rare coal chips,

hard, tight, calcareous, slightly pyritic, slightly sideritic, rare glauconite, sample 40% lost circulation material, no fluorescence or cut.

990-1020 Sandstone: 50%, gray, gray-brown, subangular, medium sorted, calcareous, carbonaceous, some stringers with slight porosity, partly oil stained, dull gold fluorescence, very slight cut; Marlstone: 30%, gray, trace brown, slightly silty, slightly carbonaceous; Siltstone: 20%, gray, gray-brown, calcareous, carbonaceous.

1020-1050 Sandstone: 65%, brown-gray to light gray, very fine grained, trace of fine grained, calcareous, carbonaceous, medium sorted, scattered siderite nodules, trace of pyrite, spotty oil stain, dull gold fluorescence, very slight yellow cut; Siltstone: 30%, gray, dark gray, calcareous, shaly, slightly carbonaceous, Shale: 5%, dark gray, slightly silty, trace carbonaceous, calcareous.

1050-1080 Sandstone: 45%, as above; Siltstone: 40%, light to dark gray, soft to hard calcareous stringers, clayey, scattered shell fragments; Shale: 10%, dark gray, calcareous, carbonaceous, Marlstone: 5%, gray, dark gray.

1080-1110 Sandstone: 25%, gray to gray-brown, subangular, moderately sorted, hard, slightly argillaceous, carbonaceous, very calcareous, no shale; Marlstone: 20%, dark gray, slightly carbonaceous, stringers calcareous dark gray shale; Siltstone: 5%, dark gray, calcareous, carbonaceous; lost circulation material 50%.

1110-1140 Sandstone: 90%, gray to salt and pepper, fine grained, subangular to subrounded, medium sorted, predominantly loose with tight calcareous streaks, quartz grains with occasional dark chert and shale granules, carbonaceous, rare quartz pebbles, no show, probable fair porosity, rare shell fragments; Siltstone: 10%, dark gray, sandy, carbonaceous, calcareous.

1140-1170 Sandstone: 80%, light gray to gray, slightly conglomeratic, quartz and dark chert pebbles, very fine to fine grained, very fine grained stringers are hard, calcareous and tight, trace pyrite, fine grained sand predominantly loose, no show; Siltstone: 20%, as above, shell fragments.

1170-1200 Sandstone: 45%, gray, light gray, very fine to fine grained, partly calcareous, partly loose, subangular, medium sorted, carbonaceous; Siltstone: 40%, light to dark gray, partly calcareous, slightly carbonaceous, sandstone inclusions; Claystone: 15%, light gray, silty, soft.

1200-1230	Siltstone: 45%, gray, dark gray, carbonaceous, siderite nodules, calcareous stringers, sandstone inclusions; Sandstone: 35%, gray, dark gray, very fine to fine grained, subangular, silty, carbonaceous, calcareous, siderite nodules, pyritic; Claystone: 20%, gray, dark gray, silty, slightly carbonaceous, sandstone inclusions.
1230-1260	Siltstone: 70%, light tan-gray, clayey, soft, tuffaceous, slightly carbonaceous; Claystone: 25%, light gray, silty, tuffaceous; Sandstone: 5%, as above.
1260-1290	Siltstone: 80%, light gray, soft, clayey, tuffaceous; Claystone: 20%, light gray, silty.
1290-1320	Claystone: 100%, light gray, soft, silty, scattered sandstone inclusions.
1320-1350	Claystone: 85%, as above; Siltstone: 15%, light gray, clayey.
1350-1380	Claystone: 100%, as above.
1380-1410	Sandstone: 50%, gray, dark gray, hard, very fine grained, subangular, silty, calcareous, carbonaceous, pyritic; Siltstone: 20%, brown-gray, hard, calcareous, carbonaceous; Coal: 15%, black, lignitic to subbituminous; Shale: 15%, dark gray, carbonaceous.
1410-1440	Claystone: 100%, light gray, soft, silty, scattered coal chips.
1440-1470	Siltstone: 50%, light gray, soft, slightly calcareous, clayey; Claystone: 45%, light gray, soft, silty, some calcareous sandstone inclusions; Sandstone: 5%, very fine grained, soft, silty, light gray.
1470-1500	Siltstone: 60%, light gray, trace medium gray, clayey, soft, pyritic, sandstone inclusions; Claystone: 40%, light gray, becoming slightly dark, silty, soft, trace crinoids.
1500-1530	Very poor sample, predominantly drilling mud and lost circulation material, 90%; Claystone: 10%, light gray, soft, silty, pyritic, siderite nodules; Limestone: trace, dark gray, very argillaceous, hard, slightly carbonaceous.
1530-1560	Sandstone: 50%, light gray, subangular, well sorted, silty, clayey, slightly pyritic, very soft and friable; Claystone: 50%, light gray, soft, silty, pyritic, scattered coal chips.
1560-1590	Claystone: 60%, light gray, silty, soft; Siltstone: 35%, light gray, clayey, soft; Sandstone: 5%, as above.

1590-1620	Sandstone: 80%, brown-gray to light gray, very fine grained, subangular to angular, quartz, dark chert and argillaceous grains, rare mica, carbonaceous, calcareous, silty, tight, trace calcite-filled fractures; Siltstone: 15%, gray, brown-gray, carbonaceous, calcareous; Shale: 15%, dark gray, carbonaceous, siderite nodules; shale and siltstone appear to be thinly interbedded.
1620-1650	Sandstone: 85%, gray, brown-gray, very fine to fine grained, calcareous, silty, carbonaceous, slightly conglomeratic, sandstone and limestone pebbles, hard, tight, pyritic, rare coal chips; Siltstone: 10%, gray, carbonaceous, calcareous; Shale: 5%, dark gray, calcareous.
1650-1680	Sandstone: 90%, brown-gray to light gray, very fine grained, silty, calcareous, carbonaceous, conglomeratic, sandstone and limestone pebbles, pyritic, clayey; Shale: brown-gray, calcareous.
1680-1710	Sandstone: 100%, light gray, conglomeratic, sandstone and limestone pebbles, fine grained, subangular, silty, slightly clayey, slightly calcareous, moderately soft and friable, siderite nodules, pyritic, no show.
1710-1740	Sandstone: 50%, light gray, gray, calcareous, carbonaceous, slightly conglomeratic, sandstone and limestone pebbles, fine grained, subangular, slightly silty; Marlstone: 35%, dark gray, slightly carbonaceous; Claystone: 15%, dark gray, calcareous, slightly carbonaceous.
1740-1770	Sandstone: 60%, light gray, gray, calcareous, slightly carbonaceous, subangular, very fine to fine grained, moderately sorted, slightly silty, trace of mica and chlorite grains, scattered limestone nodules, trace of pyrite, shell fragments, interbedded dark brown-gray marlstone and dark brown-gray calcareous claystone, 10%.
1770-1800	Sandstone: 55%, as above, trace of calcite-filled fractures; Marlstone: 30%, as above; Shale: 10%, dark brown-gray, calcareous, carbonaceous; and Siltstone: 5%, dark brown-gray, shaly, calcareous, interbedded.
1800-1830	Sandstone: 40%, gray, brown-gray, calcareous, carbonaceous, very fine grained, subangular, moderately sorted, tight, interbedded dark brown-gray, marly Shale: 45%, slightly carbonaceous; and Siltstone: 15%, dark gray-brown, calcareous, carbonaceous.
1830-1860	Shale: 45%, as above; Sandstone: 35%, as above; Siltstone: 20%, as above.

1860-1890	Shale: 60%, dark gray-brown, silty, marly, sandstone and limestone pebbles; Sandstone: 40%, as above, interbedded; very poor sample.
1890-1920	Sandstone: 50%, gray, very fine grained, subangular, silty, calcareous, slightly micaceous, slightly carbonaceous, pyritic, trace of quartz and calcite-filled fractures; Siltstone: 35%, gray, calcareous, slightly carbonaceous, trace mica, Claystone: 15%, gray, calcareous.
1920-1950	Sandstone: 50%, gray-brown, very fine grained, subangular, becoming very silty, calcareous, argillaceous, moderately sorted, slightly micaceous, pyritic; Siltstone: 35%, gray, gray-brown, calcareous, argillaceous; Claystone: 15%, gray, calcareous, interbedded.
1950-1980	Siltstone: 50%, brown-gray, light gray, calcareous, argillaceous, slightly carbonaceous; Sandstone: 45%, as above; Claystone: 5%, as above, interbedded.
1980-2010	Siltstone: 70%, brown-gray, clayey, moderately soft, scattered sandstone inclusions, slightly calcareous; Claystone: 30%, brown-gray, silty, moderately soft.
2010-2040	Claystone: 95%, light gray, silty, slightly calcareous, thin light gray, calcareous, very fine grained sandstone stringers, 5%.
2040-2070	Claystone: 85%, light gray, silty, soft; Siltstone: 15%, light gray, clayey, soft, scattered floating sand grains.
2070-2100	As above.
2100-2130	As above.
2130-2160	Claystone: 70%, as above; Siltstone: 15%, as above; Sandstone: 10%, light gray, silty, calcareous, very fine grained; Coal: 5%, black, lignitic.
2160-2190	Claystone: 40%, and Siltstone: 60%, light gray, soft.
2190-2220	Claystone: 70%, gray, silty, moderately soft; Siltstone: 20%, gray, clayey; Sandstone: 10%, gray, silty, very fine grained, subangular; very poor sample.
2220-2250	Siltstone: 8%, gray, dark gray; Claystone: 2%, gray, dark gray, slightly carbonaceous; very poor sample, predominantly lost circulation material, 90%.
2250-2280	Siltstone: 50%, gray, calcareous; Sandstone: 30%, gray, light gray, very fine grained, subangular, calcareous, slightly micaceous, silty, trace of porosity; Claystone: 20%, gray, crinoids.

2280-2310	Claystone: 80%, gray, dark gray, silty, slightly carbonaceous, pyritic; Sandstone: 10%, gray, very fine grained, calcareous, appears to be nodules; Marlstone: 10%, medium dark gray, possible nodules.
2310-2340	Sandstone: 50%, light gray, gray, very fine grained, subangular, tight to porous, porosity 10% in streaks, calcareous streaks, slightly carbonaceous and micaceous, crinoids; Claystone: 30%, light gray, gray, silty; Siltstone: 20%, light gray, gray, clayey, moderately soft.
2340-2370	Siltstone: 15%, gray, light gray, moderately soft; Sandstone: 10%, gray, very fine grained, subangular, slightly carbonaceous, silty, argillaceous, micaceous, moderately friable, 10%(?) porosity; Claystone: 5%, gray, slightly carbonaceous, pyritic; very poor sample, predominantly lost circulation material, 70%.
2370-2400	Claystone: 70%, gray, micaceous, slightly carbonaceous, pyritic; Sandstone: 20%, gray, very fine grained, subangular, slightly carbonaceous, silty, argillaceous, moderately soft, slight porosity; Siltstone: 10%, gray, clayey, slightly carbonaceous.
2400-2430	Claystone: 80%, as above; Sandstone: 10%; Siltstone: 10%, as above.
2430-2460	Siltstone: 70%, medium dark gray, argillaceous, slightly calcareous, carbonaceous; Claystone: 20%, medium dark gray, silty, carbonaceous, pyritic; Sandstone: 10%, medium dark gray, very fine grained, subangular, carbonaceous, silty, sandstone appears to be thin stringers.
2460-2490	Siltstone: 80%, as above, pyritic; Claystone: 15%, Sandstone: 5%, trace of shell fragments.
2490-2520	Siltstone: 90%, as above; Claystone: 10%; occasional trace of sandstone.
2520-2550	Claystone: 60%, medium gray, dark gray, silty, pyritic, slightly carbonaceous; Siltstone: 30%, medium gray, clayey, slightly carbonaceous; Sandstone: 10%, gray, light gray, very fine grained, subangular, silty, rare fossil fragments, Inoceramus.
2550-2580	As above.
2580-2610	Siltstone: 60%, gray, argillaceous, moderately soft, slightly carbonaceous; Claystone: 30%, medium gray, silty; Sandstone: gray, very fine grained, soft, friable, 10% porosity, silty, argillaceous.

2610-2640	Siltstone: 50%, as above; Claystone: 35%, as above; Sandstone: 15%, as above.
2640-2670	Claystone: 70%, gray, trace of dark gray, carbonaceous, silty, Inoceramus; Siltstone: 30%, as above.
2670-2700	Claystone: 50%, as above; Siltstone: 30%; Shale: 15%, dark gray, micaceous, carbonaceous, fissile, pyritic; Sandstone: 5%, gray, very fine grained, subangular, calcareous.
2700-2730	As above.
2730-2760	Claystone: 75%, gray, dark gray, carbonaceous, soft; Siltstone: 15%, gray, clayey, soft; Shale: 10%, dark gray, micaceous, thin beds.
2760-2790	Very poor sample; sample 99% lost circulation material; trace of dark gray, silty, carbonaceous shale, one foraminifera, rare coal chips and siderite chips.
2790-2820	Siltstone: 65%, gray, carbonaceous, slightly sandy, pyritic, slightly calcareous; Shale: 30%, dark gray, carbonaceous, silty; Sandstone: 5%, light gray, very fine grained, subangular, moderately sorted, silty, argillaceous, slightly calcareous, no show.
2820-2850	Very poor sample; 95% lost circulation material; Siltstone: 3%, as above; Shale: 2%, as above, coaly streaks, pyritic.
2850-2880	Claystone: 60%, gray, light gray, pyrite inclusions, slightly carbonaceous; Siltstone: 30%, light gray, gray, slightly calcareous, slightly carbonaceous; Sandstone: 10%, gray, very fine grained, subangular, calcareous, tuffaceous, slightly carbonaceous, trace of light gray limestone, occasional coal chips.
2880-2910	Claystone: 70%, as above, Inoceramus; Siltstone: 25%, as above; Sandstone: 5%, as above.
2910-2940	Claystone: 80%, as above; Siltstone: 20%, as above, Inoceramus, trace of dark gray shale.
2940-2970	Siltstone: 50%, light gray, tuffaceous, calcareous, slightly carbonaceous, partly soft and friable; Claystone: 35%, as above; Sandstone: 15%, light gray, very fine grained, subangular, moderately sorted, tuffaceous, silty, slightly calcareous.
2970-3000	Sandstone: 70%, light gray, gray, very fine to fine grained, with a trace of medium grains, subangular to

angular, medium sorted, dark argillaceous, carbonaceous and chert grains common, slightly calcareous, white clay matrix, tuffaceous(?), estimated 12% porosity, occasional siderite nodules, gas kick 400-1,056 units, no fluorescence or cut; Siltstone: 25%, gray, slightly calcareous, slightly carbonaceous, moderately soft; Shale: dark to medium gray, micaceous, carbonaceous, shale and siltstone interbeds; sandstone at 2980-2995' with gas kick.

3000-3030 Sandstone: 60%, light gray, gray, very fine to fine grained, moderately sorted, calcareous, white clay matrix, tuffaceous, carbonaceous, slightly micaceous, porosity streaks to 10%; interbedded Siltstone: 30%, light to medium gray, slightly calcareous, tuffaceous, carbonaceous, trace mica, and Shale: 10%, medium dark gray, carbonaceous, pyritic, siderite nodules, Inoceramus; gas begins dropping at 3000', back to 50 units at 3015'.

3030-3060 Siltstone: 50%, light gray, partly sandy, slightly calcareous, carbonaceous, moderately soft, interbedded Sandstone: 25%, as above, and Shale: 25%, medium to dark gray, partly carbonaceous, siderite nodules, scattered pyrite nodules, Inoceramus; gas kick at 3030-3035', 168 units; back to 60 units at 3040'.

3060-3090 Sandstone: 65%, light gray, gray, very fine to fine grained, trace medium grained, angular to subangular, medium sorted, calcareous, slightly carbonaceous, tuffaceous, scattered siderite nodules, interbedded Shale: 35%, medium dark gray, slightly carbonaceous, micaceous.

3090-3120 Shale: 60%, as above, coaly partings, becoming partly silty, interbedded Siltstone: 25%, as above, and Sandstone: 15%, as above.

3120-3150 Shale: 70%, medium to dark gray, silty, slightly carbonaceous, partly claystone, trace of pyrite, interbedded Siltstone: 15%, light gray, clayey, moderately soft; and Sandstone: 15%, light gray, gray, very fine to fine grained, slightly carbonaceous, slightly calcareous, tuffaceous, some siderite nodules.

3150-3180 Shale: 75%, as above, interlaminated Sandstone: 15%, as above, and Siltstone: 10%, as above.

3180-3210 Shale: 80%, medium gray, dark streaks, slightly carbonaceous, micaceous, slightly silty, pyrite inclusions, interlaminated Sandstone: 10%, as above, and Siltstone: 10%, as above.

3210-3240	Shale: 70%, medium dark gray, slightly carbonaceous and micaceous, firm, interlaminated Siltstone: 20%, gray, carbonaceous, slightly calcareous, and Sandstone: 10%, very fine grained, subangular, slightly tuffaceous.
3240-3270	Claystone: 75%, gray, silty, sandstone inclusions, moderately soft, tuffaceous, pyrite inclusions, interlaminated Siltstone: 10%, gray, soft, clayey, and Sandstone: 15%, light gray, gray, very fine to fine grained, tuffaceous.
3270-3300	Claystone: 90%, as above, scattered siderite nodules, interlaminated Siltstone: 10%, as above.
3300-3330	Claystone: 75%, as above, trace of medium dark gray shale, rare pyrite inclusions, foraminifera; interlaminated Siltstone: 25%, gray, slightly carbonaceous, micaceous, Inoceramus.
3330-3360	Claystone: 60%, gray, silty, sandstone inclusions; Shale: 10%, dark gray, carbonaceous, slightly micaceous; Siltstone: 20%, gray, clayey, interbedded; Bentonite: 10%, very light gray, micaceous.
3360-3390	Shale: 65%, gray and dark gray stringers, carbonaceous, micaceous, silty streaks; Siltstone: 25%, gray, clayey, moderately soft; Sandstone: 10%, gray, very fine grained, subangular, interlaminated.
3390-3420	Shale: 75%, dark gray, micaceous, slightly fissile, carbonaceous; Siltstone: 20%, gray, clayey; Sandstone: 5%, as above.
3420-3450	Siltstone: 45%, gray, clayey, soft; Shale: 40%, dark gray, as above; Sandstone: 15%, gray, very fine grained, subangular, clayey, silty, soft, interbedded.
3450-3480	Shale: 60%, gray, dark gray, micaceous, slightly carbonaceous, partly fissile, pyrite inclusions; Siltstone: 25%, gray, clayey, soft; Sandstone: 15%, gray, very fine grained, subangular, calcareous, clayey, interbedded.
3480-3510	Claystone: 65%, light gray, silty, occasional coal chips; Shale: 20%, gray, dark gray, slightly carbonaceous, as above; Siltstone: 15%, light gray, clayey, soft.
3510-3540	Claystone: 60%, as above; Siltstone: 40%, light gray, soft.
3540-3570	Claystone: 50%, gray, silty; Shale: 40%, dark gray, slightly carbonaceous, fissile, pyritic; Sandstone: 10%, gray, very fine grained, subangular, silty, calcareous.

3570-3600	Claystone: 40%, gray, dark gray, silty, pyritic; Shale: 30%, dark gray, as above; Siltstone: 15%, gray, clayey, slightly calcareous; Sandstone: 15%, gray, very fine grained, subangular, calcareous, tuffaceous, Inoceramus.
3600-3630	Claystone: 50%, as above; Shale: 30%, as above; Siltstone: 15%, as above; Sandstone: 5%, as above.
3630-3660	Claystone: 60%; Shale: 30%; Siltstone: 10%, as above.
3660-3690	Shale: 50%: dark gray, carbonaceous, silty, slightly fissile, micromicaceous, pyritic; Siltstone: 30%, gray, dark gray, slightly carbonaceous, shaly; Sandstone: 20%, medium and dark gray, very fine grained, subangular, silty, very slightly calcareous, carbonaceous, interbedded fossil fragments, trace of gray marlstone.
3690-3720	Claystone: 70%, medium and dark gray, slightly silty, trace of pyrite; Shale: 25%, dark gray, as above; Siltstone: 5%, gray, as above.
3720-3750	Claystone: 70%, gray, silty, moderately soft, scattered pyrite inclusions, interbedded Shale: 15%, dark gray, slightly carbonaceous, micaceous, and Siltstone: 15%, gray, clayey, moderately soft.
3750-3780	Claystone: 55%, as above, Inoceramus common; Shale: 35%, as above; Siltstone, 10%: as above.
3780-3810	Claystone: 50%; Shale: 40%; Siltstone: 10%: as above, Inoceramus common.
3810-3840	Claystone: 65%; Shale: 30%; Siltstone: 5%, as above.
3840-3870	Claystone: 65%; Shale: 25%; Siltstone: 10%, bentonitic streaks, Inoceramus.
3870-3900	Claystone: 50%; Shale: 35%; Siltstone: 15%, rare bentonitic streaks, Inoceramus, as above.
3900-3930	Shale: 60%, dark gray, carbonaceous, micaceous, partly fissile, pyrite inclusions, Inoceramus; Siltstone: 20%, gray, clayey, soft; Claystone: 20%, gray, silty, soft; bentonite stringer, very light gray.
3930-3960	Shale: 50%, as above; Siltstone: 30%, as above; Claystone: 20%, as above; trace of sandstone.
3960-3990	Shale: 70%, as above; Siltstone: 15%, as above; Sandstone: 15%, light gray, very fine to fine grained, subangular, tuffaceous, calcareous, rare glauconitic grains, interlaminated.

3990-4020	Shale: 90%, dark gray, carbonaceous, fissile, slightly micaceous, scattered pyrite inclusions, Inoceramus; Siltstone: 5%, gray, clayey; Sandstone: 5%, as above, interlaminated.
4020-4050	Shale: 80%, as above, interlaminated Siltstone: 10%; and Sandstone: 10%, as above.
4050-4080	Shale: 85%, dark gray, carbonaceous, micaceous, pyrite inclusions, Inoceramus, fissile, interbedded Siltstone: 15%, gray, clayey, trace of sandstone.
4080-4110	Shale: 80%, as above; Siltstone: 10%, as above; Sandstone: 10%, gray, very fine grained, subangular, carbonaceous, silty, slightly calcareous, micaceous.
4110-4140	Shale: 65%, as above, interbedded Sandstone: 20%, medium and light gray, very fine to fine grained, subangular, medium sorted, silty, calcareous, carbonaceous; Siltstone: 10%, gray, slightly carbonaceous and calcareous, clayey; Bentonite: 5%, very light gray, micaceous, carbonaceous; rare foraminifera.
4140-4170	Shale: 75%, as above; interbedded Sandstone: 15%; and Siltstone: 10%, as above.
4170-4200	Shale: 65%, as above; interbedded Sandstone: 20%, as above, partly bentonitic; Siltstone: 15%, as above.
4200-4230	Shale: 75%, dark gray, carbonaceous, micaceous, slightly silty, slightly fissile, pyritic, Inoceramus, interlaminated Sandstone: 15%, gray, very fine grained, subangular, silty, slightly carbonaceous, micaceous, and Siltstone: 10%, gray, argillaceous.
4230-4260	Shale: 80%; Sandstone: 10%; Siltstone: 10%, as above.
4260-4320	Shale: 9%, dark gray, as above; Siltstone; 1%; very poor sample; changed screens, predominantly lost circulation material, 90%.
4320-4350	Shale: 85%, dark gray, slightly carbonaceous, slightly micaceous, partly fissile, scattered pyrite inclusions, Inoceramus, Siltstone laminations: 15%, gray, carbonaceous, argillaceous.
4350-4380	Shale: 90%, as above; Siltstone: 10%, as above, trace of light gray, very fine grained calcareous sandstone.
4380-4400	Shale: 80%; Siltstone: 10%; Sandstone: 10%, light gray, gray, very fine grained, subangular to angular, silty, carbonaceous, argillaceous, moderately friable.

4400-4420	Shale: 85%, dark to very dark gray, slightly carbonaceous, fissile, micromicaceous, pyrite inclusions, Inoceramus, rare limestone nodules, interlaminated Siltstone: 15%, gray, dark gray, micaceous, argillaceous.
4420-4440	Shale: 90%; Siltstone: 10%, as above.
4440-4460	Shale: 80%; Siltstone: 10%, as above; Sandstone: 10%, gray, very fine grained, subangular, calcareous, slightly carbonaceous, slightly micaceous, silty.
4460-4480	Shale: 70%; Siltstone: 10%; Sandstone: 20%: as above.
4480-4500	Shale: 80%; Siltstone: 10%; Sandstone: 10%: as above.
4500-4520	Shale: 85%, dark and very dark gray, micromicaceous, slightly carbonaceous, partly fissile, some pyrite inclusions, Inoceramus; thin beds and laminations of Siltstone: 10%, gray, dark gray, shaly, slightly carbonaceous; and Sandstone: 5%, gray, light gray, slightly calcareous, carbonaceous, slightly micaceous, siderite grains.
4520-4540	Shale: 75%, as above; Siltstone: 15%; Sandstone: 10%, as above.
4540-4560	Shale: 65%; Siltstone: 20%, light gray, clayey, calcareous, moderately soft; Sandstone: 15%, light gray, very fine grained, subangular, medium sorted, calcareous, silty, slightly carbonaceous, slightly sideritic.
4560-4580	Shale: 75%; Siltstone: 10%; Sandstone: 15%, as above, becoming fine grained.
4580-4600	As above.
4600-4620	Shale: 85%, dark gray, very dark gray, slightly carbonaceous, slightly micaceous, partly fissile, slightly pyritic, Inoceramus, Siltstone laminations: 10%, gray, slightly carbonaceous and calcareous; Sandstone: 5%, light gray, very fine to fine grained, carbonaceous, slightly calcareous.
4620-4640	Shale: 70%, as above; Siltstone: 20%; Sandstone: 10%, as above.
4640-4660	Shale: 50%; Siltstone: 30%, light brown-gray, gray, clayey, moderately soft, dusty, trace of oil stain, and Sandstone: 20%, light gray, very fine to fine grained, subangular, slightly calcareous, slightly carbonaceous, micaceous, argillaceous.

4660-4680	Shale: 60%; Siltstone: 30%; Sandstone: 10%, as above.
4680-4700	Shale: 70%; Siltstone: 25%; Sandstone: 5%, as above.
4700-4720	Shale: 75%, dark and very dark gray, slightly carbonaceous, fissile, micaceous, pyrite inclusions, Inoceramus; thin bedded and interlaminated Siltstone: 20%, gray, slightly carbonaceous, moderately friable, and Sandstone: 5%, light gray, very fine to fine grained, subangular, carbonaceous, micaceous, calcareous.
4720-4740	Shale: 80%; Siltstone: 15%; Sandstone: 5%, as above.
4740-4760	Shale: 90%; Siltstone: 10%, as above.
4760-4780	Shale: 90%; Siltstone: 10%, as above.
4780-4800	Shale: 70%; Siltstone: 15%; Sandstone: 15%, as above.
4800-4820	Shale: 75%, dark gray, slightly carbonaceous and micaceous, fissile, pyrite inclusions, scattered siderite nodules, Inoceramus; interlaminated Siltstone: 20%, gray, soft, micaceous, slightly calcareous, and Sandstone: 5%, light gray, gray, calcareous, slightly carbonaceous, micaceous.
4820-4840	Shale: 75%, as above; Siltstone: 25%, as above.
4840-4860	Shale: 60%, as above; Siltstone: 15%, as above; Sandstone: 25%, light gray, very fine to fine grained, subangular to angular, shale partings, carbonaceous, tuffaceous, silty, slightly calcareous, scattered siderite grains.
4860-4880	Shale: 70%; Siltstone: 15%; Sandstone: 15%, as above.
4880-4900	As above.
4900-4920	Shale: 70%, dark gray, very dark gray, fissile, slightly carbonaceous, slightly micaceous, pyritic, rare limestone nodules, interbedded Sandstone: 20%, light and medium gray, very fine to fine grained, subangular, medium sorted, silty, tuffaceous, some siderite grains, very slightly calcareous, rare glauconitic grains, and Siltstone: 10%, dark to medium gray, shaly, slightly carbonaceous, slightly calcareous.
4920-4940	As above.
4940-4960	Shale: 80%; Siltstone: 10%; Sandstone: 10%, as above.

4960-4980	Shale: 80%; Siltstone: 10%; Sandstone: 10%, as above.
4980-5000	Shale: 70%; Sandstone: 20%; Siltstone: 10%, as above.
5000-5010	Shale: 60%, dark gray, fissile, partly silty, micromicaceous, pyritic, Inoceramus, interbedded Sandstone: 25%, light and medium gray, very fine to fine grained, medium sorted, calcareous, slightly carbonaceous, rare glauconite, silty; Siltstone: 15%, medium to light gray, partly shaly, slightly calcareous, and carbonaceous.
5010-5020	Shale: 50%; Sandstone: 30%; Siltstone: 20%, as above.
5020-5030	Shale: 50%; Sandstone: 30%; Siltstone: 20%, as above.
5030-5040	Shale: 60%; Sandstone: 25%; Siltstone: 15%, as above.
5040-5050	Shale: 60%; Sandstone: 15%; Siltstone: 25%, as above.
5050-5060	Shale: 45%; Sandstone: 35%; Siltstone: 20%, as above.
5060-5070	As above; Sandstone becoming less calcareous.
5070-5080	Shale: 60%; Sandstone: 15%; Siltstone: 25%, as above.
5080-5090	Shale: 55%, dark to very dark gray, micromicaceous, slightly carbonaceous, pyrite inclusions, Inoceramus, interbedded Sandstone: 30%, light to medium gray, very fine to fine grained, carbonaceous, tuffaceous, partly shaly, slightly micaceous, silty, and Siltstone: 15%, gray, dark gray, micaceous, slightly carbonaceous.
5090-5100	Shale: 60%; Sandstone: 25%; Siltstone: 15%, as above.
5100-5110	As above.
5110-5120	Shale: 55%; Sandstone: 30%; Siltstone: 15%, as above.
5120-5130	Shale: 60%; Sandstone: 25%; Siltstone: 15%, as above.
5130-5140	Shale: 60%; Sandstone: 30%; Siltstone: 10%, as above.
5140-5150	Shale: 70%, dark and very dark gray, silty, micaceous, pyritic, slightly carbonaceous; Sandstone: 20%, medium and light gray, very fine grained, subangular, medium sorted, carbonaceous, very slightly calcareous, light gray streaks moderately calcareous, micaceous, silty, and Siltstone: 10%, gray, carbonaceous, partly shaly.
5150-5160	Shale: 60%, as above; Sandstone: 30%, as above, trace ofvery light gray, subangular, fine grained, calcareous, quartzose sandstone; Siltstone: 10%, as above.

5160-5170	Shale: 50%, as above; Sandstone: 35%, medium to very light gray, very fine to fine grained, subangular to subrounded, medium sorted, calcareous to shaly, dark carbonaceous and argillite grains, probably very thin bedded and laminated, fine grained sandstone appears to have slight porosity; Siltstone: 15%, gray, carbonaceous, micaceous.
5170-5180	Shale: 40%, as above; Sandstone: 30%, as above; Siltstone: 30%, as above, Inoceramus.
5180-5190	Shale: 60%, as above, Inoceramus; Sandstone: 25%, as above, trace becoming sideritic; Siltstone: 15%, as above.
5190-5200	Shale: 65%, as above; Sandstone: 20%, as above; Siltstone: 15%, as above, sands becoming predominantly very fine grained.
5200-5240	No returns. Lost circulation at 5279', samples may have gone into lost circulation zone.
5240-5250	Shale: 80%, very dark gray, carbonaceous, silty streaks, fissile, pyrite inclusions; Sandstone: 10%, light gray, very fine grained, subangular, slightly carbonaceous, silty, argillaceous; Siltstone, 10%: gray, dark gray, shaly, slightly carbonaceous, no show.
5250-5260	As above.
5260-5270	As above.
5270-5280	Sandstone: 85%, light gray, very fine grained, partly fine grained, subrounded, predominantly loose, quartzose with scattered dark carbonaceous grains, silty, very slightly calcareous, trace of white clayey cement, friable, probable fair to good porosity; Shale: 15%, as above.
5280-5290	Lost circulation material, 98%, trace of loose sand and chips, as above.
5290-5320	No returns. By-passed shakers with lost circulation material.
5320-5330	Shale: 10%, dark gray, silty, slightly carbonaceous, micromicaceous; very poor sample, predominantly lost circulation material, 90%.
5330-5340	Shale: 60%, dark gray, carbonaceous, micromicaceous, fissile, pyritic; Sandstone: 30%, light gray, very fine grained, subangular, carbonaceous, calcareous, silty, scattered loose, fine and medium grained quartz and gray

chert grains, rare angular, clear, medium to coarse quartz grains in samples; contamination from mica used in lost circulation material; Siltstone: 10%, gray, dark gray, shaly.

5340-5350 No sample.

5350-5360 Shale: 60%, very dark gray, micromicaceous, slightly carbonaceous, pyrite inclusions, partly fissile, Inoceramus, interbedded Sandstone: medium to light gray, very fine grained, subangular, medium sorting, carbonaceous, micaceous, calcareous, silty stringers, slight porosity, 3-5%; Siltstone: medium and dark gray, carbonaceous, shaly; no show.

5360-5370 Shale: 35%, as above; Sandstone: 55%, as above, stringers with fair porosity; Siltstone: 10%, as above; no show.

5370-5380 Very poor sample, 75% lost circulation material; Shale: 15%; Sandstone: 5%; Siltstone: 5%, as above; no show.

5380-5390 Very poor sample; Shale: 70%; Sandstone: 20%; Siltstone: 10%; no show.

5390-5400 Shale: 50%, dark and very dark gray, partly silty, carbonaceous, micromicaceous, interbedded Sandstone: 40%, medium to light gray, very fine grained, subangular, trace of loose fine grains, carbonaceous, silty, partly calcareous, slightly micaceous, no show; Siltstone: 10%, medium to dark gray, carbonaceous, shaly.

5400-5410 Shale: 60%; Sandstone: 30%; Siltstone: 10%.

5410-5420 Shale: 60%; Sandstone: 25%; Siltstone: 10%, as above, trace of medium and coarse grained sand: loose, subangular, white and buff quartz, red chert, rare grains with hematite stain, rare siderite grains.

5420-5430 Sandstone: 50%, medium to light gray, very fine grained, subangular, carbonaceous, micaceous, silty, argillaceous; Shale: 30%, dark gray, slightly carbonaceous, silty stringers, partly micromicaceous; Siltstone: 20%, dark gray, gray, carbonaceous, shaly.

5430-5440 Shale: 45%; Sandstone: 35%; Siltstone: 20%, as above.

5440-5450 Shale: 35%; Sandstone: 50%; Siltstone: 15%, as above.

5450-5460 Shale: 60%; Sandstone: 25%; Siltstone: 15%, as above; Inoceramus.

5460-5470	Shale: 50%; Sandstone: 30%; Siltstone: 20%, as above; Inoceramus.
5470-5480	Shale: 55%; Sandstone: 30%; Siltstone: 15%, as above.
5480-5490	Very poor sample; Shale: 80%; Siltstone: 20%, as above.
5490-5500	Shale: 60%; Sandstone: 10%; Siltstone: 15%, as above.
5500-5510	Shale: 60%; Sandstone: 10%; Siltstone: 30%, very poor sample.
5510-5520	Shale: 60%, dark to very dark gray, slightly carbonaceous, micromicaceous, silty stringers, pyritic inclusions, Inoceramus; Sandstone: 25%, light gray, very fine grained, subangular, silty, argillaceous, slightly carbonaceous, very slightly calcareous; Siltstone: 15%, medium to dark gray, carbonaceous, shaly.
5520-5530	Shale: 20%, very dark gray, as above; Siltstone: 5%; Sandstone: 5%; very poor sample; predominantly lost circulation material, 70%.
5530-5540	Shale: 15%, as above; Sandstone: 10%; Siltstone: 5%; very poor sample, 70%, as above; .
5540-5550	Shale: 60%, very dark to dark gray, micromicaceous, slightly carbonaceous, moderately fissile, interbedded Sandstone: 30%, light gray, very fine grained, subangular, carbonaceous, silty, argillaceous, slightly micaceous; Siltstone: 10%, gray, dark gray, carbonaceous, very poor sample.
5550-5560	Shale: 65%; Sandstone: 25%; Siltstone: 15%, as above.
5560-5570	Shale, Sandstone, and Siltstone: as above; very poor sample.
5570-5580	Shale: 70%, as above; Inoceramus; Sandstone: 15%, as above; Siltstone: 15%, as above; rare glauconite in sandstone, rare loose subrounded, medium sand grains.
5580-5590	Shale: 65%, as above; Sandstone: 25%, as above, trace of calcite veins or fracture fillings; Siltstone: 10%, gray, dark gray, carbonaceous.
5590-5600	Shale: 65%, dark and very dark gray, moderately fissile, micromicaceous, silty stringers, slightly carbonaceous, trace of pyrite inclusions, Inoceramus, interbedded Sandstone: 20%, light gray, very fine grained, subangular, medium sorted, scattered fine quartz and

gray chert grains; carbonaceous, silty, argillaceous, very slightly calcareous, slightly pyritic; Siltstone: 15%, medium to dark gray, slightly carbonaceous, argillaceous, trace of medium subrounded quartz and gray chert grains, loose; shale appears slightly lighter than above, some brownish tinge.

5600-5610 Shale: 60%; Sandstone: 20%; Siltstone: 20%, as above.

5610-5620 Shale: 60%; Sandstone: 20%; Siltstone: 20%, as above.

5620-5630 Shale: 70%; Sandstone: 15%; Siltstone: 15%, as above.

5630-5640 Shale: 40%, dark to medium gray, silty, partly carbonaceous, micaceous; Sandstone: 20%, as above; Siltstone: 40%, medium and dark gray, soft, clayey, slightly carbonaceous; very poor sample.

5640-5650 Shale: 60%, very dark gray, slightly carbonaceous, blocky to fissile, micromicaceous, silty stringers, pyrite inclusions, interbedded Sandstone: 25%, light to medium gray, very fine grained, some fine grained stringers, silty, carbonaceous flakes, argillaceous; Siltstone: 15%, medium to dark gray, carbonaceous, micaceous, partly shaly.

5650-5660 Shale: 70%, as above; brown-gray stringers; Sandstone: 15%; Siltstone: 15%, as above.

5660-5670 As above.

5670-5680 Shale: 80%, Inoceramus, limestone nodules; Sandstone: 10%; Siltstone: 10%, as above.

5680-5690 Shale: 70%, as above; Sandstone: 10%; Siltstone: 20%, as above.

5690-5700 Shale: 65%; Sandstone: 10%; Siltstone: 25%, as above.

5700-5710 Shale: 70%, very dark gray, fissile, micromicaceous, slightly carbonaceous, interbedded Siltstone: 30%, medium and dark gray, shaly, trace of sandstone.

5710-5720 Shale: 65%, as above; Sandstone: 10%, light gray, very fine grained, subangular, silty, argillaceous; Siltstone: 25%, medium to dark gray, as above; partly soft and clayey.

5720-5730 Shale: 60%, as above; Sandstone: 25%, as above, slightly calcareous, slightly porous; Siltstone: 15%, as above, one frosted Quartz granule: angular, part of pebble.

5730-5740	Shale: 75%; Sandstone: 10%; Siltstone: 15%.
5740-5750	Shale: 70%, dark gray to brown-gray, micromicaceous, silty, stringers, blocky to fissile, Inoceramus, interbedded Siltstone: 25%, brown-gray, micaceous, shaly, trace of Sandstone: 5%, light gray, very fine grained, silty.
5750-5760	Shale: 80%, as above, trace of pyrite; Siltstone: 10%, as above; Sandstone: 10%, as above.
5760-5770	Shale: 75%, as above; Sandstone: 15%; Siltstone: 10%, as above.
5770-5780	Shale: 75%, dark gray to gray-brown, stringers very dark gray, silty, pyrite inclusions; Siltstone: 15%, light and medium gray, argillaceous; Sandstone: 10%, light gray, very fine grained, slightly carbonaceous, silty, rare green grains, glauconite(?), slightly carbonaceous, partly calcareous, rare rounded, medium and coarse frosted quartz grains, trace of Inoceramus prisms, contaminated.
5780-5790	Shale: 100%, as above.
5790-5800	Shale: 80%, as above; Sandstone: 20%, gray, very fine grained, silty, slightly carbonaceous.
5800-5810	Shale and Sandstone: as above.
5810-5820	Shale: 65%, as above; Sandstone: 35%, light to medium gray, subangular, carbonaceous grains, silty, poor porosity; no show.
5820-5830	Very poor sample; predominantly lost circulation material, 90%; Shale: 10%, very dark gray, micaceous, trace of sandstone and siltstone.
5830-5840	Shale: 60%, dark gray; Sandstone: 40%, light to very light gray, part salt and pepper, very fine to fine grained, carbonaceous grains, scattered dark chert grains, very light gray sandstone is very calcareous, poor porosity.
5840-5850	Shale: 70%, dark gray, gray-brown; Sandstone: 30%, light gray, very fine to fine grained, silty, argillaceous, carbonaceous, no show, poor porosity.
5850-5860	Sandstone: 50%, light gray, slightly salt and pepper, very fine to fine grained, subangular, dark carbonaceous and chert grains, micaceous, coaly partings, silty, argillaceous, very slightly calcareous, rare green grains, chlorite, poor porosity; Shale and Siltstone: as above.

5860-5870	Shale: 35%; Sandstone: 50%; Siltstone: 15%, as above.
5870-5880	Shale: 50%, as above; Sandstone: 40%, light gray, very fine to fine grained stringers, subangular, carbonaceous, silty, argillaceous, poor to fair porosity; Siltstone: 10%.
5880-5890	Shale: 55%, as above; Sandstone: 30%, as above; Siltstone: 15%.
5890-5900	Shale: 65%, dark gray, gray-brown, silty stringers, trace coal; Sandstone: medium to light gray, very fine and fine grained streaks, scattered medium grains, dark chert and carbonaceous grains, coal partings, fine grained streaks are calcareous, poor porosity.
5900-5910	Shale: 70%, dark gray, trace of gray-brown; Sandstone: 25%, light gray, salt and pepper, fine grained, very fine grained stringers, carbonaceous, calcareous, rare green grains, poor to fair porosity, Siltstone: 5%, gray, gray-brown, shaly.
5910-5920	Shale: 55%, as above; Sandstone: 30%, light gray, partly salt and pepper, fine grained, scattered medium grains, subangular, medium sorted, carbonaceous, some dark chert grains, calcareous, silty, fair porosity; Siltstone: 15%, brown-gray, dark gray, micaceous.
5920-5930	Shale: 50%, dark gray, dark brown-gray, silty, micaceous; Sandstone: 30%, light to medium gray, very fine to fine grained, subangular, carbonaceous grains, slightly micaceous, silty, calcareous; Siltstone: 20%, dark gray, trace of brown-gray, carbonaceous, interbedded.
5930-5940	Shale: 60%; Sandstone: 25%; Siltstone: 15%, as above.
5940-5950	Shale: 50%; Sandstone: 35%; Siltstone: 15%, as above.
5950-5960	Lost circulation 5965'; Shale: 30%, as above, pyrite inclusions; Sandstone: 55%, light gray, part salt and pepper, very fine to fine grained, subangular, medium sorted, carbonaceous, silty, coal grains, argillaceous, poor to fair porosity; no show; Siltstone: 15%, dark gray, gray, carbonaceous, slightly micaceous.
5960-5970	Shale: 35%; Sandstone: 50%; Siltstone: 15%, as above.
5970-5980	Very poor sample; predominantly lost circulation material, trace of very dark gray Shale, light gray, very fine grained sandstone and brown-gray siltstone.
5980-5990	Shale: 50%, dark gray, brown-gray; Sandstone: 25%; Siltstone: 25%, as above.

5990-6000	Sandstone: 65%, light gray, slightly salt and pepper, very fine to fine grained, subangular, carbonaceous, scattered quartz and chert grains, silty, argillaceous, poor to fair porosity, no show, gas kick; Siltstone: 15%, gray, dark gray, slightly carbonaceous and micaceous, argillaceous; Shale: 20%, as above.
6000-6010	Shale: 20%; Sandstone: 50%; Siltstone: 30%, as above.
6010-6020	Very poor sample; predominantly lost circulation material, trace of very dark gray shale and siltstone, trace of sandstone.
6020-6030	Very poor sample; lost circulation material, 70%; Shale: 20%, very dark gray, trace gray-brown, micaceous, carbonaceous; Sandstone: 5%, gray, light gray, very fine grained, carbonaceous, silty; Siltstone: 5%, gray, dark gray.
6030-6040	Very poor sample; highly contaminated with cement and lost circulation material, 75%; Shale: 10%, as above; Sandstone: 5%, gray, as above; Siltstone: 10%, gray, dark gray, as above.
6040-6050	Very poor sample, as above, 75%; Shale: 15%, dark gray, brown-gray, carbonaceous, micaceous, silty; Sandstone: 5%, as above; Siltstone: 5%.
6050-6060	Shale: 70%, as above, siderite nodules; Sandstone: 10%, as above; Siltstone: 20%, as above.
6060-6070	Shale: 80%, very dark to dark gray, carbonaceous, slightly fissile, trace of pyrite, micromicaceous; Sandstone: 5%; Siltstone: 15%, as above.
6070-6080	Shale: 75%; Sandstone: 15%; Siltstone: 10%, as above.
6080-6090	Shale: 70%, dark gray, trace brown-gray, partly silty, micaceous, carbonaceous; Sandstone: 15%, medium to light gray, very fine grained, subangular, carbonaceous, silty, slightly micaceous, argillaceous, no show; Siltstone: 15%, dark gray, gray, carbonaceous, shaly, micaceous.
6090-6100	Shale: 65%; Sandstone: 10%; Siltstone: 25%, as above.
6100-6110	Shale: 55%; Sandstone: 15%; Siltstone: 30%, as above.
6110-6120	Shale: 50%; Siltstone: 35%; Sandstone: 15%, as above.
6120-6130	Shale: 40%, as above; Sandstone: 20%, gray, very fine grained, subangular, carbonaceous, silty, argillaceous, trace of mica, tight; Siltstone: 40%, gray, dark gray, carbonaceous, micaceous, shaly.

6130-6140	Shale: 65%; Sandstone: 15%; Siltstone: 20%, as above.
6140-6150	Shale: 55%, dark and very dark gray, becomes slightly brown; Sandstone: 15%, medium and light gray, very fine grained, subangular, carbonaceous, silty, argillaceous, trace of mica, tight; Siltstone: 30%, dark to medium gray, trace slightly brown, carbonaceous, shaly, micaceous.
6150-6160	Shale: 65%; Sandstone: 15%; Siltstone: 20%, as above.
6160-6170	Shale: 65%, Sandstone: 15%, and Siltstone: 20%, as above, trace of fluorescence and stain.
6170-6180	Sandstone: 60%, brown-gray, light gray, very fine grained to fine grained stringers, subangular, carbonaceous, silty, Clay cement: slightly micaceous, poor porosity, slightly stained, bright, blue-white fluorescence, slight yellow-white cut until broken, streaming blue-white cut; gas kick 980 units, C_1, C_2, C_3, trace C_4; Shale: 30%, as above; Siltstone: 10%, as above;
6180-6190	Shale: 25%; Sandstone: 60%; Siltstone: 15%, as above, interbedded; gas decreasing, fluorescence and cut, as above.
6190-6200	Shale: 30%; Sandstone: 50%; Siltstone: 20%; fluorescence and cut become light yellow-white.
6200-6210	Sandstone: 60%, gray, slightly brown, very fine to fine grained stringers, subangular, carbonaceous, silty, argillaceous, poor porosity, slightly stained, yellow-white cut; Shale: 30%, dark to very dark gray, micaceous, partly carbonaceous; Siltstone: 10%, dark gray, carbonaceous, shaly, thin shale and siltstone interbedding.
6210-6220	Sandstone: 70%; Shale: 20%; Siltstone: 10%, as above.
6220-6230	Sandstone: 70%; Shale: 20%; Siltstone: 10%, as above.
6230-6240	Sandstone: 60%, light gray, slightly brown, very fine to fine grained stringers, subangular, slightly carbonaceous, silty, argillaceous, slightly siliceous, slightly stained, white-yellow fluorescence, slight cut, good when broken; Shale: 25%, Inoceramus; Siltstone: 15%, dark gray, brown-gray, shaly, thin interbeds.
6240-6250	Shale: 25%; Sandstone: 60%; Siltstone: 15%, as above.

6250-6260	Sandstone: 55%, gray to very light gray, very fine to fine grained stringers, subangular, rare glauconite, siliceous stringers, spotty brown stain, poor porosity, spotty white-yellow fluorescence, slight cut until broken; Shale: 30%, dark and very dark gray, trace brown-gray, as above; Siltstone: 15%, dark gray, brown-gray, shaly, thin interbeds.
6260-6270	Sandstone: 60%, as above, increasingly fine grained; Siltstone: 15%, as above; Shale: 25%: as above.
6270-6280	Shale: 40%, very dark gray, black, dark brown-gray, micromicaceous, partly carbonaceous, pyrite inclusions, micaceous; Sandstone: 45%, light gray, slightly brown, very fine to fine grained, subangular, carbonaceous and gray chert grains, argillaceous, slightly siliceous, poor porosity, spotty light yellow fluorescence, slight cut; Siltstone: 15%, as above.
6280-6290	Shale: 40%, black to dark brown-gray, fissile, carbonaceous, silty stringers, micromicaceous; Sandstone: 40%, as above; Siltstone: 20%, as above; spotty white-yellow fluorescence and cut, as above.
6290-6300	Shale: 60%, increasing brown-gray, as above, trace pyrite; Sandstone: 25%, as above, coal chips; Siltstone: 15%, as above; fluorescence and cut, as above.
6300-6310	Shale: 60%, as above; Sandstone: 25%, medium to light gray, very fine to fine grained, subangular, carbonaceous, coaly partings, silty, argillaceous, partly siliceous, poor porosity, slightly stained, spotty light yellow fluorescence and cut; Siltstone: 15%, dark gray, brown-gray, carbonaceous, shaly; scattered fossil fragments (Ammonite).
6310-6320	Shale: 50%, dark gray to brown-gray, micromicaceous, silty stringers, stringers of light brown, soft, tuffaceous, pyritic, shale; Sandstone: 30%, as above, trace of pyrite; Siltstone: 20%, as above.
6320-6330	Shale: 60%, as above, rare light gray bentonitic shale; Sandstone: 25%; Siltstone: 15%.
6330-6340	Shale: 60%, very dark gray, black, dark brown-gray, carbonaceous, partly silty, scattered siderite nodules, rare subrounded, fine floating quartz grains; Sandstone: 20%, dark gray, gray, very fine to fine grained, subangular, partly very carbonaceous, silty, argillaceous; Siltstone: 20%, dark gray, gray, gray-brown, shaly, carbonaceous.

6340-6350	Shale: 80%, as above, thin, very light gray bentonitic shale stringers, scattered floating sand grains, foraminifera; Siltstone: 15%; Sandstone: 5%.
6350-6360	Shale: 75%, as above, pyritic, light brown, tuffaceous shale partings; Siltstone: 25%; Sandstone: 5%.
6360-6370	Shale: 80%, very dark gray to gray-brown, fissile, partly silty, floating medium to coarse, rounded quartz grains, some black chert pebbles, Inoceramus; Siltstone: 15%; Sandstone: 5%.
6370-6380	Shale: 100%, as above, light gray bentonitic shale stringers, trace of glauconite, floating quartz grains, Inoceramus.
6380-6390	Shale: 75%, slight increase in brown-gray, floating quartz, pyrite; Siltstone: 15%, as above; Sandstone: 10%, light gray, brown, very fine grained, subangular, silty, shaly, carbonaceous; trace of bentonitic shale, and light gray calcareous tuff.
6390-6400	Shale: 75%, as above; Siltstone: 20%, dark brown-gray, shaly; Sandstone: 5%, as above.
6400-6410	Shale: 85%, as above, trace coaly partings, Inoceramus, trace bentonitic shale; Siltstone: 10%; Sandstone: 5%, as above.
6410-6420	Shale: 90%, as above, foraminifera, floating grains of pyrite, bentonitic shale stringers; Siltstone: 10%.
6420-6430	Shale: 80%, as above, trace cherty shale, coal partings; Siltstone: 10%; Sandstone: 10%, trace of bentonitic shale.
6430-6440	Shale: 90%, black to very dark gray, carbonaceous, micromicaceous, pyritic, floating quartz grains, trace of coal.
6440-6450	Shale: 70%, very dark to dark gray, slightly brown, silty, blocky, pyritic, carbonaceous, floating quartz grains; Siltstone: 20%, dark gray to brown-gray, shaly, carbonaceous, interbedded Sandstone: 10%, light gray, gray, very fine to fine grained, subangular, scattered dark chert grains, silty, carbonaceous, argillaceous.
6450-6460	Shale: 75%, as above, floating quartz grains, dark chert granules; Siltstone: 15%; Sandstone: 10%, trace of light gray Bentonite: silty.
6460-6470	Shale: 80%, as above; Siltstone: 15%; Sandstone: 5%, trace of white zeolite crystals, and gray-brown tuffaceous clay.

6470-6480	Shale: 85%, as above; Siltstone: 15%, quartz grains, partly granule in size, trace of coal, thin partings.
6480-6490	Shale: 90%, as above, rounded quartz granules, dark chert pebbles; Siltstone: 10%; trace of sandstone.
6490-6500	Shale: 80%, as above, trace of glauconite, thin bentonitic clay partings, quartz grains; Siltstone: 15%; Sandstone: 5%.
6500-6510	Shale: 60%, as above, floating quartz grains, common dark chert pebbles and quartz granules; Siltstone: 30%, dark gray, brown-gray, carbonaceous, argillaceous, micaceous; Sandstone: 10%, gray, very fine grained, subangular, silty, dolomitic, hard, tight.
6510-6520	Shale: 65%, very dark to dark gray, pyritic, carbonaceous, floating quartz grains and granules, dark chert granules, thin Sandstone laminations: 10%, medium to dark gray, shaly to argillaceous, carbonaceous, trace of Quartz conglomerate: shaly; Siltstone: 25%, gray, dark gray, carbonaceous, micaceous.
6520-6530	Shale: 70%, as above; Sandstone: 15%, as above, partly brown, stained, slightly glauconitic; Siltstone: 15%, as above, interbedded.
6530-6540	Shale: 40%, as above; Sandstone: 30%, gray to gray-green, very fine grained, subangular, partly silty, argillaceous, calcareous streaks, abundant glauconite pellets and matrix, trace of limestone nodules, appears slightly stained; no fluorescence, cut or gas kick; Siltstone: 30%, gray, gray-brown, partly glauconitic, sandy; glauconite is fine to coarse grained.
6540-6550	Shale: 65%; Sandstone: 10%; Siltstone: 25%, abundant glauconite, as above.
6550-6560	Shale: 60%, dark to medium gray, silty, floating quartz grains, carbonaceous, pyritic, trace of glauconite, interbedded Siltstone: 30%, gray, brown-gray, glauconite pellets common, partly sideritic, slight iron staining; Sandstone: 10%, gray, brown-gray, partly glauconitic, partly sideritic, carbonaceous, silty, argillaceous, streaks of bentonitic shale.
6560-6570	Shale: 60%, as above; Siltstone: 20%, as above; Sandstone: 20%, as above, becomes partly light gray, slightly carbonaceous, glauconitic.

6570-6580	Sandstone: 40%, gray-brown, gray, very fine grained, subangular, abundant glauconite pellets and matrix, sideritic, silty, glauconite partly altered, no fluorescence or cut, nil porosity; Siltstone: 30%, gray, brown-gray, partly glauconitic, shaly; Shale: 30%, as above;
6580-6590	Shale: 50%, trace coal; Sandstone: 20%; Siltstone: 30%, as above.
6590-6600	Siltstone: 50%, very dark gray to brown, glauconitic, shaly, sideritic, iron stain; Sandstone: 20%, light gray to brown, silty, glauconitic, partly calcareous, very fine grained, subangular; Shale: 30%.
6600-6610	Shale: 50%; Siltstone: 20%; Sandstone: 40%, as above.
6610-6620	Shale: 40%, very dark to dark gray, silty, slightly glauconitic, floating quartz grains; Siltstone: 50%, light to dark gray, partly very glauconitic, shaly, partly sideritic, rare siderite nodules, bentonitic shale stringers, glauconite pellets are very fine to coarse grain size; Sandstone: 10%, light gray, very fine grained, subangular, partly glauconitic, carbonaceous.
6620-6630	Siltstone: 50%, as above; Shale: 30%, as above, glauconite stringers; Sandstone: 20%, as above.
6630-6640	Shale: 50%, dark chert granules, as above; Siltstone: 30%; Sandstone: 20%, as above.
6640-6650	Shale: 50%, as above; Siltstone: 20%; Sandstone: 30%, as above, slightly pyritic, slightly porous; no fluorescence or cut.
6650-6660	Shale: 50%, as above; Siltstone: 20%; Sandstone: 30%, as above.
6660-6670	Shale: 40%, as above; Siltstone: 20%; Sandstone: 40%, very light to light gray, very fine grained, subangular, slightly calcareous, silty, slightly siliceous, disseminated pyrite, very slightly porous stringers.
6670-6680	Shale: 30%; Sandstone: 50%; Siltstone: 20%, as above, scattered limestone nodules.
6680-6690	Shale: 40%; Sandstone: 40%; Siltstone: 20%, Inoceramus.
6690-6700	Shale: 40%; Sandstone: 30%; Siltstone: 30%, as above.
6700-6710	Shale: 50%, very dark gray, dark brown-gray, partly micaceous, pyritic, some floating quartz grains, trace of glauconite, interbedded Sandstone, 15%: light to medium

gray, very fine grained, subangular, silty, argillaceous, slightly carbonaceous; Siltstone: 35%, light to medium gray, dark gray, slightly carbonaceous, argillaceous, pyritic, sandy.

6710-6720 Shale: 50%; Sandstone: 10%; Siltstone: 40%, as above.

6720-6730 Shale: 50%; Sandstone: 10%; Siltstone: 40%, as above.

6730-6740 Shale: 40%; Sandstone: 20%; Siltstone: 40%, glauconite pellets, trace of fine grained, subangular quartzose, sandstone, cream colored altered grains, tripolitic chert, loose, round, siliceous, clay grains, altered chert(?).

6740-6750 Shale: 35%, as above, glauconite stringers, occasional calcite inclusions, possible altered fossils; Siltstone: 50%, very light to medium gray, slightly sandy, micaceous, shaly stringers, stringers slightly porous, very slightly calcareous, moderately to very siliceous, Sandstone: 15%, light to medium gray, very fine grained, subangular, silty, loose tan and buff, siliceous clay grains, altered chert(?); scattered dark chert grains, rounded.

6750-6760 Siltstone: 50%, light gray, brown-gray, argillaceous, siliceous, very slightly calcareous, partly sideritic; Shale: 20%, very dark gray, micromicaceous, pyritic, partly glauconitic, some floating quartz grains; Sandstone: 20%, gray, brown-gray, very fine grained, subangular, argillaceous, silty, slightly siliceous, trace of quartzose sandstone, angular, white altered grains, tripolitic chert(?), medium grained, siliceous, porous; loose grains common, calcite grains, subangular, medium to coarse grained, scattered brown chert grains, buff and tan grains, as above, trace of fossil fragments, partly pyritic.

6760-6770 Shale: 50%, as above; Siltstone: 40%, brown-gray, light gray, argillaceous, slightly sandy, pyritic, siliceous stringers; Sandstone: 10%, as above, occasional loose grains, as above.

6770-6780 Shale: 30%, as above; Siltstone: 50%, light to medium gray, slightly sandy, argillaceous, partly siliceous, rare glauconite and pyrite; Sandstone: 20%, light and medium gray, very fine grained, subangular, silty, argillaceous, slightly siliceous.

6780-6790 Shale: 40%; Siltstone: 50%; Sandstone: 10%: as above.

6790-6800 Shale: 30%; Siltstone: 60%, becoming brown-gray; Sandstone: 10%, as above.

6800-6810	Siltstone: 60%, gray-brown, shaly, siliceous stringers, micaceous, pyritic, carbonaceous; Shale: 30%, very dark gray to dark brown-gray, partly silty, partly carbonaceous, trace of glauconite and pyrite, siderite nodules; Sandstone: 10%, brown-gray, very fine grained, silty, argillaceous, pyritic, partly carbonaceous.
6810-6820	Shale: 50%; Siltstone: 30%; Sandstone: 10%, as above.
6820-6830	Shale: 70%, floating quartz grains; Siltstone: 30%.
6830-6840	Shale: 65%; Siltstone: 30%; Sandstone: 5%, as above, trace of gray-brown siderite with glauconite pellets, trace of light gray bentonitic shale, cavings(?).
6840-6850	Shale: 50%, very dark gray to brown-gray, floating quartz grains, rare pyrite, fissile to blocky, scattered very coarse, rounded chert grains; Siltstone: 40%, gray, brown-gray, very slightly calcareous, micromicaceous, streaks with siderite, and Sandstone: 10%, light gray to brownish-gray, very fine grained, subangular, silty, slightly calcareous, sideritic, as above.
6850-6860	Siltstone: 50%; Shale: 40%; Sandstone: 10%, as above.
6860-6870	Siltstone: 50%; Shale: 30%; Sandstone: 20%, as above, trace light of gray bentonitic shale.
6870-6880	Siltstone: 50%; Shale: 40%; Sandstone: 10%, as above, trace of bentonitic shale, rare quartz pebbles.
6880-6890	Siltstone: 50%; Shale: 40%; Sandstone: 10%, as above, foraminifera, thin partings of brown-gray limestone, black chert pebbles.
6890-6900	Siltstone: 45%, as above; Shale: 40%; Sandstone: 15%, gray, very fine grained, subangular, argillaceous, silty, very slightly carbonaceous.
6900-6910	Very poor sample; predominantly lost circulation material, 90%, Shale: 8%, dark brown-gray, micaceous, slightly silty; Siltstone: 2%, dark brown-gray, shaly, slightly carbonaceous; trace of limy shale; trace of iron staining.
6910-6920	Shale: 80%, dark gray, dark brown-gray, micaceous, silty, rare siderite nodules with glauconite, scattered floating quartz grains and granules, interlaminated Siltstone: 15%, dark gray-brown, micaceous, shaly; Sandstone: 5%, gray, very fine grained, subangular, argillaceous, slightly carbonaceous.

6920-6930	Shale: 75%; Siltstone: 25%, as above.
6930-6940	Shale: 80%; Siltstone: 20%; trace of sandstone, as above.
6940-6950	Shale: 85%, dark brown-gray, micaceous, silty stringers, fissile, trace of pyrite, carbonaceous; Siltstone: 15%, dark brown-gray, shaly, micaceous, carbonaceous; trace of sandstone, interlaminated.
6950-6960	Shale: 85%; Siltstone: 15%; trace of sandstone, trace of light gray, bentonitic shale.
6960-6970	Shale: 80%, as above, rare floating quartz grains; Siltstone: 20%.
6970-6980	Shale: 85%; Siltstone: 10%, as above; Sandstone: 5%, light gray, gray, silty, argillaceous, interlaminated.
6980-6990	Shale: 70%, very dark gray to brown-gray, micromicaceous, pyritic, floating round quartz grains, rare dark chert pebbles and glauconite; Siltstone: 25%, brown-gray to gray-brown, argillaceous; Sandstone: 5%, medium to light gray, fine grained, silty, siliceous, very slightly calcareous; sample poor, partly cavings.
6990-7000	Shale: 70%; Siltstone: 20%; Sandstone: 10%, as above, partly gray-brown, trace of siderite with glauconite, trace of bentonitic shale.
7000-7010	Shale: 85%, as above, floating quartz grains, siderite pellets; Siltstone: 15%, as above; trace of sandstone.
7010-7020	Shale: 80%; Siltstone: 15%; Sandstone: 5%, as above, trace of light gray, bentonitic shale.
7020-7030	Shale: 80%, dark gray to dark gray-brown, micaceous, slightly carbonaceous, scattered floating quartz grains, trace of pyrite, interlaminated Siltstone: 15%, gray-brown, shaly, micaceous; Sandstone: 5%, light gray-brown, very fine grained, subangular, shaly, trace of bentonitic shale.
7030-7040	Shale: 70%, as above, trace of black, floating quartz grains, dark chert granules, siderite inclusions with glauconite pellets; Siltstone: 25%; Sandstone: 5%, as above.
7040-7050	Shale: 60%, becoming partly brown; bentonitic shale stringers; Siltstone: 30%; Sandstone: 10%, as above.

7050-7060	Shale: 60%; Siltstone: 30%, as above; Sandstone: 10%, light gray, gray-brown, argillaceous, micaceous, very fine grained, subangular, slightly carbonaceous.
7060-7070	Shale: 65%, gray-brown to dark gray, fissile streaks, silty stringers, trace of pyrite, scattered rounded quartz grains, interbedded Siltstone: 35%, brown-gray to dark gray, shaly in part, slightly carbonaceous, trace of fossil fragments.
7070-7080	Shale: 60%, as above, siderite inclusions with glauconite; Siltstone: 35%, as above; Sandstone: 5%, brown-gray, very fine grained, carbonaceous, micaceous, silty, argillaceous.
7080-7090	Shale: 80%, as above, rare large pyrite inclusions; Siltstone: 20%; trace of sandstone.
7090-7100	Shale: 80%; Siltstone: 20%, as above.
7100-7110	Shale: 70%, gray-brown to dark gray, partly silty, pyrite inclusions, scattered rounded quartz grains, interbedded Siltstone: 30%, brown-gray, shaly, slightly micaceous, slightly calcareous, trace of sandstone.
7110-7120	Shale: 50%, as above, slightly glauconitic, rare siderite nodules; Siltstone: 50%, siliceous streaks.
7120-7130	Siltstone: 65%, brown-gray, gray, carbonaceous, slightly micaceous, glauconitic, slightly sandy, slightly calcareous, and Shale: 30%, as above; pyrite streaks and inclusions, interlaminated Sandstone: 5%, light gray, brown-gray, very fine grained, subangular, micaceous, silty, argillaceous.
7130-7140	Shale: 30%, as above, siderite and pyrite common; Siltstone: 60%; Sandstone: 10%, partly pyritic.
7140-7150	Siltstone: 65%; Shale: 25%, Sandstone: 10%, as above.
7150-7160	Siltstone: 80%, gray-brown, brown-gray, glauconitic, micaceous, slightly carbonaceous, sandy streaks, pyrite inclusions, slightly calcareous; Shale: 20%, dark gray, dark gray-brown, slightly micaceous, fissile, pyritic.
7160-7170	Siltstone: 70%, becoming shaly; Shale: 30%, as above.
7170-7180	Siltstone: 60%, as above; Shale: 30%; Sandstone: 10%, gray-brown, very fine grained, subangular, silty, slightly carbonaceous, trace of mica, slightly calcareous, partly shaly, interlaminated.

7180-7190	Siltstone: 55%; Shale: 30%; Sandstone: 15%, as above.
7190-7200	Siltstone: 50%; Shale: 40%; Sandstone: 10%, as above.
7200-7210	Siltstone: 50%, brown-gray, brown, slightly micaceous, glauconitic; Shale: 40%, brown, fissile, silty, glauconitic, slightly carbonaceous; Sandstone: 10%, brown-gray, very fine grained, subangular, slightly glauconitic, carbonaceous, argillaceous, silty, interlaminated.
7210-7220	Shale: 40%, as above; Siltstone: 60%, as above.
7220-7230	Shale: 50%; appears to be darker than above; Siltstone: 50%, as above.
7230-7240	Siltstone: 60%; Shale: 40%, as above.
7240-7250	Shale: 60%, dark brown, dark brown-gray, micromicaceous, silty, pyritic, stringers, glauconitic; Siltstone: 40%, as above, Inoceramus.
7250-7260	Siltstone: 55%, brown-gray, gray-brown, micaceous, argillaceous, very slightly carbonaceous, slightly pyritic; Shale: 40%, as above; Sandstone: 5%, brown-gray, very fine grained, subangular, silty, argillaceous.
7260-7270	Siltstone: 50%, as above, trace brown with glauconite; Shale: 40%, partly dark gray, rare glauconite pellets; Sandstone: 10%, light brown-gray, very fine to fine grained, silty, argillaceous.
7270-7280	Siltstone: 60%, as above; Shale: 40%; foraminifera.
7280-7290	Shale: 60%; Siltstone: 40%, as above, scattered floating quartz grains.
7290-7300	Very poor sample; iron flakes, 80%; pipe scale; Shale: 5%; Siltstone: 15%.
7300-7310	Siltstone: 60%, brown-gray to gray-brown, trace of gray, slightly carbonaceous, partly shaly, slightly siliceous, pyritic, rare glauconite; Shale: 40%, gray-brown to dark brown-gray, silty, carbonaceous, slightly micaceous, rare glauconite pellets.
7310-7320	Shale: 50%; Siltstone: 45%, as above; Sandstone: 5%, light gray, very fine grained, subangular, silty, rare carbonaceous grains.
7320-7330	Siltstone: 60%; Shale: 40%, as above; rare floating quartz grains; foraminifera.

7330-7340	Siltstone: 70%, gray, dark brown-gray, slightly micaceous, carbonaceous, pyritic, partly shaly; Shale: 30%, gray-brown, dark brown-gray, silty, carbonaceous, pyrite inclusions, micaceous.
7340-7350	Shale: 70%, dark gray, micaceous, partly silty, pyritic, rare glauconite, floating quartz grains; Siltstone: 30%, as above.
7350-7360	Shale: 70%, as above, dark gray-brown, glauconitic streaks with green clay and pellets, increasing pyrite; Siltstone: 30%, as above.
7360-7370	Shale: 70%, as above, rare dark chert grains; Siltstone: 30%, as above.
7370-7380	Siltstone: 60%, as above; Shale: 40%; foraminifera.
7380-7390	Siltstone: 50%; Shale: 30%; Sandstone: 20%, light gray, very fine grained, subangular, silty, calcareous, slightly siliceous, predominantly loose in sample.
7390-7400	Siltstone: 75%, very light and light gray, slightly brown, slightly sandy, siliceous, slightly sideritic, thin glauconite pellet stringers with green glauconitic clay matrix, pellets to 1/2 mm; Sandstone: 15%, light and very light gray, slightly brown, very fine grained, subangular, very silty, siliceous, sideritic, glauconitic, as above; Shale: 10%, as above;
7400-7410	Siltstone: 70%, light gray, light brown-gray, part sideritic, siliceous, trace of glauconite pellets; Shale: 25%, dark gray, dark brown-gray, silty, micaceous, slightly carbonaceous; Sandstone: 5%, as above, some glauconite pellets, siderite cement.
7410-7420	Siltstone: 70%, as above; Shale: 25%; Glauconite pellet stringers: 5%, green glauconitic clay matrix, 1/2 mm pellets, appear to be partly limonite.
7420-7430	Shale: 45%, dark gray, slightly brown, micaceous, slightly carbonaceous, silty, scattered glauconite pellets; Siltstone: 55%, gray, dark gray, slightly brown, carbonaceous, partly shaly, slightly glauconitic, stringers with light gray, black carbonaceous grains.
7430-7440	Shale: 60%, as above; Siltstone: 40%, as above, some sandy streaks.
7440-7450	Shale: 50%, very dark brown-gray, silty, micaceous, pyritic, trace of black pelletoid claystone; Siltstone: 50%, very dark and dark gray, shaly, slightly carbonaceous, thin light gray streaks, rare glauconite.

7450-7460	Shale: 75%, as above, trace of glauconite; Siltstone: 20%, as above; Sandstone: 5%, very light gray, very fine grained, subangular to subrounded, siliceous, slightly calcareous, silty.
7460-7470	Sandstone: 45%, very light gray to light brown-gray, very fine grained, subangular to subrounded, calcareous, siliceous, silty, some black grains, rare chips with siderite; Shale: 25%, as above, trace glauconite; Siltstone: 30%, as above;
7470-7480	Sandstone: 50%; Shale: 25%; Siltstone: 25%, as above.
7480-7490	Sandstone: 95%, very light gray, very fine grained, subangular to subrounded, scattered black and very dark gray, carbonaceous and chert grains, rare glauconite, siliceous, very slightly calcareous, some argillaceous bands, rare gray chert inclusions, no fluorescence, very slight pale yellow cut from crushed chips; Shale: 5%.
7490-7500	Sandstone: 85%; Shale: 10%; Siltstone: 5%, as above.
7500-7510	Sandstone: 95%; increased glauconite, very slight porosity; Shale: 5%.
7510-7520	Sandstone: 75%, as above, gray streaks; Shale: 15%, dark gray with medium gray streaks, slightly micaceous; Siltstone: 10%, brown-gray, gray, slightly micaceous, shaly, slightly carbonaceous.
7520-7530	Sandstone: 100%, very light and light gray, very fine grained, fine grained partings, subangular to subrounded, scattered black grains, trace of white grains, appear altered, possible tripolitic chert, slightly glauconitic, slightly calcareous, siliceous, poor porosity, no shows.
7530-7540	Sandstone: 90%, as above, occasional brown stringers, increased glauconite, poor porosity; no show; Shale: 10%, dark brown-gray, brown, micaceous, trace of glauconite.
7540-7550	Sandstone: 95%, as above, rare shell fragments, slightly calcareous, trace of calcite veins, poor to fair porosity; Shale: 5%.
7550-7560	Sandstone: 95%, as above, calcareous stringers, glauconite common; Shale: 5%.
7560-7570	Sandstone: 95%, as above; Shale: 5%.

7570-7580	Sandstone: 95%, light gray, gray and brown stringers, very fine grained, partly fine grained, subangular, silty, siliceous, slightly calcareous, slightly argillaceous, glauconitic, argillaceous stringers, rare shell fragments, poor porosity; Shale: 5%, gray, dark gray, smooth, partly silty;
7580-7590	Sandstone, 95%, as above; poor to fair porosity; Shale: 5%.
7590-7600	Sandstone, 95%, as above, fair porosity, trace of crystalline calcite, fracture fill(?); Shale: 5%.
7600-7610	Sandstone: 95%, increasing clayey matrix, siltstone laminations, rare shell fragments, poor porosity; Shale: 5%.
7610-7620	Sandstone: 80%, as above; Shale: 10%; Siltstone: 10%, light gray, gray, sandy, clayey, slightly glauconitic.
7620-7630	Sandstone: 80%, light gray, medium gray streaks, very fine grained, subangular, clayey cement, slightly siliceous, very slightly calcareous, increased silt, decreasing glauconite; Shale: 10%; Siltstone: 10%, as above.
7630-7640	Sandstone: 70%, as above; Shale: 20%, gray to dark brown, becoming silty, micaceous, pyritic, slightly carbonaceous; Siltstone: 10%, as above; scattered shell fragments.
7640-7650	Sandstone: 70%, as above, trace brown siderite, glauconite pellets; Shale: 20%, as above; Siltstone: 10%.
7650-7660	Sandstone: 60%; Shale: 30%; Siltstone: 10%, as above.
7660-7670	Sandstone: 50%, as above; Shale: 40%, dark brown-gray, dark brown, partly silty, siltstone laminations, pyritic, slightly micaceous, slightly carbonaceous; Siltstone: 10%, brown-gray, slightly micaceous, shaly.
7670-7680	Sandstone: 70%, very light gray to light brown-gray, very fine grained, subangular, glauconitic, calcareous streaks, siliceous, argillaceous streaks, silty, siderite stringers with glauconite pellets; Shale: 10%, as above; Siltstone: 20%, gray to brown, partly siliceous, slightly glauconitic, argillaceous, slightly calcareous, shaly partings.

7680-7690	Sandstone: 40%; light to medium brown, very fine to fine grained, angular, calcareous, argillaceous, partly iron stained, slightly glauconitic, fossil fragments; Limestone: 25%, light to medium brown, partly coquina, detrital, sandy, argillaceous; Claystone: 20%, light brown, mottled, calcareous, appears iron stained, fossil fragments, partly caliche; Siltstone: 10%, gray to gray-brown, argillaceous, calcareous, fossil fragments; Shale: 5%, as above; appears to be weathered zone, possible local unconformity(?).
7690-7700	Limestone: 50%, gray-brown, coquina, sandy, argillaceous, glauconitic; Sandstone: 30%, brown-gray, very fine to fine grained, subangular to angular, limy, glauconitic, fossiliferous; Shale: 10%; Siltstone: 10%.
7700-7710	Shale: 40%, dark gray-brown, micaceous, silty, slightly calcareous, fossil fragments; Siltstone: 40%, brown-gray, calcareous, shaly, fossiliferous; Limestone: 20%, as above.
7710-7720	Shale: 70%, as above, pyritic; Siltstone: 10%; Limestone: 10%, as above; Sandstone: 10%, light brown-gray, fine to very fine grained, subangular, calcareous, trace of dead oil, loose calcite crystals, veins(?).
7720-7730	Shale: 85%, as above, fossiliferous; Siltstone: 15%, shaly, fossiliferous, coarse calcite crystals, veins(?).
7730-7740	Shale: 80%; Siltstone: 20%, calcite veins, as above.
7740-7750	Shale: 80%; fossiliferous; Siltstone: 20%, as above.
7750-7760	Shale: 70%; fossiliferous; Siltstone: 30%; calcareous, as above.
7760-7770	Shale: 50%; Siltstone: 50%, calcareous, pyrite, fossiliferous, as above.
7770-7780	Shale: 60%; Siltstone: 40%, as above.
7780-7790	Siltstone: 60%, calcareous, carbonaceous; Shale: 40%, as above.
7790-7800	Siltstone: 60%; Shale: 40%, fossil casts.
7800-7810	Siltstone: 70%, dark brown-gray, brown, partly carbonaceous, calcareous, rare pyrite inclusions, shell fragments, corals; Shale: 30%, dark gray-brown, micaceous, silty, carbonaceous, fossil fragments.

7810-7820	Siltstone: 70%, as above; Shale: 30%, foraminifera.
7820-7830	Shale: 50%; Siltstone: 50%, as above.
7830-7840	Siltstone: 60% and Shale: 40% interlaminated; rare, very coarse dark chert grains.
7840-7850	Shale: 60%; Siltstone: 40%; chert grains, as above.
7850-7860	Siltstone: 60%, trace of altered fossils with tarry oil stain; Shale: 40%.
7860-7870	Shale: 60%; Siltstone: 40%, as above, corals, fossiliferous.
7870-7880	Shale: 55%; Siltstone: 45%, as above.
7880-7890	Shale: 60%; Siltstone: 40%, fossiliferous, trace of very light gray, very fine grained sandstone, caving(?).
7890-7900	Shale: 50%; Siltstone: 50%, as above, becoming partly sideritic, siderite partings, silty.
7900-7910	Shale: 60%, dark gray, slightly brown, micaceous, carbonaceous, partly silty, pyritic, calcareous; Siltstone, 40%: dark brown-gray, shaly, carbonaceous, brown streaks, sideritic, calcareous, corals, scattered shell fragments.
7910-7920	Shale: 70%; Siltstone: 30%, as above.
7920-7930	Shale: 70%; Siltstone: 30%, as above, fossil fragments.
7930-7940	Shale: 70%; Siltstone: 30%, as above, dark brown, siderite streaks, fossil fragments.
7940-7950	Shale: 70%; Siltstone: 30%, sideritic streaks, as above.
7950-7960	Shale: 75%; Siltstone: 25%, as above, rare coarse dark chert grains.
7960-7970	Shale: 75%; Siltstone: 25%, as above, fossil fragments, trace of sandstone.
7970-7980	Shale: 60%; Siltstone: 40%, as above, fossiliferous, becoming slightly sandy.
7980-7990	Siltstone: 60%; Shale: 40%; foraminifera, slightly sandy.
7990-8000	Shale: 40%, dark gray, slightly brown, silty streaks, slightly carbonaceous and calcareous, pyritic, pelecypods; Siltstone: 50%, dark gray, slightly brown, carbonaceous,

shaly, calcareous, partly sandy; Sandstone: 10%, dark gray, very fine grained, subangular, silty, shaly, slightly carbonaceous, calcareous.

8000-8010 Siltstone: 70%; Shale: 20%; Sandstone: 10%, as above.

8010-8020 Siltstone: 90%, dark brown-gray, sandy, carbonaceous, glauconitic, slightly micaceous, calcareous, pyritic, thin sandstone partings, rare shell fragments, shale laminations; Shale: 10%, as above.

8020-8030 Siltstone: 90%; Shale: 10%, fossiliferous.

8030-8040 Siltstone: 70%, fossiliferous, some light gray, very fine grained, calcareous sandstone streaks; Shale: 30%, as above.

8040-8050 Siltstone: 70%, as above; Shale: 20%, dark gray, gray, partly silty, pyritic, micromicaceous; Sandstone: 10%, as above.

8050-8060 Siltstone: 60%, as above; Sandstone: 30%, brown-gray, gray, very fine grained, subangular, silty, calcareous, slightly glauconitic, partly shaly, shell fragments, interlaminated; Shale: 10%.

8060-8070 Siltstone: 45%; Sandstone: 50%, as above, black, shiny grains, gilsonite(?); Shale: 5%.

8070-8080 Siltstone: 45%; Shale: 15%; Sandstone: 40%, as above, fossil fragments.

8080-8090 Siltstone: 40%; Sandstone: 40%, as above, very limy; Limestone: 10%, gray, very sandy, argillaceous, scattered black pellets, phosphate(?); some fossils, interlaminated; Shale: 10%, trace of phosphate pellets.

8090-8100 Siltstone: 60%, dark to light gray, shaly streaks, calcareous, pyrite inclusions, slightly carbonaceous, fine fossil debris; Sandstone: 40%, gray, light gray, very fine grained, calcareous, argillaceous, carbonaceous, very slightly pyritic.

8100-8110 Siltstone: 70%, dark gray, gray, carbonaceous, shaly, calcareous, slightly sandy, trace of shell fragments; Sandstone: 20%, as above; Shale: 10%, very dark gray, carbonaceous, micaceous, hard.

8110-8120 Siltstone: 60%; Sandstone: 25%; Shale: 15%, as above.

8120-8130 Siltstone: 65%, dark to light gray, slightly calcareous, argillaceous, carbonaceous; Sandstone: 15%, light to

medium gray, very fine grained, subangular, slightly calcareous, shaly, trace of glauconite, interlaminated pyrite inclusions; Shale: 20%, black, silty, scattered black phosphate pellets.

8130-8140 Siltstone: 50%, as above; Shale: 20%, black, hard, phosphatic, phosphate pellets, partly altered, brown, slightly iron stained; pellet stringers; Sandstone: 10%, as above; Limestone: 20%, light gray to light brown, coquina, argillaceous, shaly; interlaminated.

8140-8150 Limestone: 60%, dark to light gray, partly coquina, shaly streaks, argillaceous, partly pyritic, some phosphate pellets; Shale: 15%; Siltstone: 25%, as above.

8150-8160 Limestone: 35%, as above; Sandstone: 25%, light gray, fine grained, subangular, calcareous, slightly argillaceous, phosphate pellets, carbonaceous, pyrite inclusions; Shale: 20%; Siltstone: 20%, as above.

8160-8170 Sandstone: 80%, dark gray to gray-brown, very fine to fine grained, calcareous, argillaceous, shaly stringers, slightly pyritic, silty, fossil fragments, phosphate pellets, very slight porosity, slight stain, very faint cut; Shale: 15%, dark gray, silty, rare phosphate pellets; Limestone: 5%, as above.

8170-8180 Sandstone: 55%, as above, becoming shaly; Shale: 20%, fossil casts, partly phosphatic; Siltstone: 10%; Limestone: 15%, light brown-gray, very fossiliferous, argillaceous, pyrite inclusions.

8180-8190 Sandstone: 60%, dark gray to dark gray-brown, very fine grained, subangular, calcareous to shaly, fossil fragments, phosphate nodules and pellets, pyrite inclusions; Shale: 10%; Siltstone: 30%, dark gray to brown, shaly, sandy, very slightly calcareous; trace of limestone; interlaminated.

8190-8200 Siltstone: 40%; Sandstone: 35%, Shale: 20%; Limestone: 5%; trace dark gray chert granules.

8200-8210 Sandstone: 55%, very light gray, fine grained, subangular, quartzitic, scattered siderite pellets, rare chert pebbles; Siltstone: 30%, very light gray with tan mottling, siliceous, quartzitic in part, siderite pellets; Claystone: 15%, buff, very siliceous, siderite pellets.

8210-8220 Sandstone: 100%, very light gray, clear, medium to coarse grained, angular to rounded, siliceous, very conglomeratic with buff, white and gray chert pebbles, scattered pyrite crystals, partly quartzitic; no show.

8220-8230	Conglomerate: 100%, very light to light gray, buff to gray chert pebbles, angular to rounded, clear to very light gray, medium to coarse grained, siliceous sandstone matrix, scattered pyrite, white opaque grains, tripolitic chert(?), poor porosity; no show.
8230-8240	Sandstone: 95%, very light gray, tan-gray, medium to coarse grained, very conglomeratic, subrounded, siliceous, trace white clay cement, pebbles very light to medium gray, trace of pyrite, tripolitic chert; no show; Shale: 5%, light tan-gray, micaceous, partly siliceous.
8240-8250	Conglomerate: 100%, buff to gray chert pebbles, medium to very coarse grain sandstone matrix, siliceous, trace of white clay, tripolitic chert grains, starting to become buff colored, some tan grains; no show.
8250-8260	Conglomerate: 95%, as above; Shale: 5%, brick red to red-pink, fissile, to red-brown with sand grains.
8260-8270	Conglomerate: 95%, as above; Shale, 5%: as above, trace of gray mottling; trace of light gray shale, micaceous, scattered pyrite; no show.
8270-8280	Sandstone: 100%, clear to pink, fine to coarse grained, conglomeratic, siliceous, white altered grains, abundant very coarse angular chert, a few chips with rounding, fractured pebbles(?), trace of shale, as above.
8280-8290	Sandstone: 100%, pink-brown, fine grained, subangular to angular, siliceous, very slightly dolomitic, trace of white clay cement, scattered altered white grains, slightly conglomeratic, slightly sideritic, very slightly porous; no show.
8290-8300	Sandstone: 100%, as above, trace of red shale, fair porosity.
8300-8310	Sandstone: 100%, as above, increasingly white and clear sandstone, trace of medium and coarse grained sandstone; trace of red shale, fair porosity; no show.
8310-8320	Sandstone: 100%, white, clear to pink, partly mottled, fine to coarse grained, conglomeratic, angular to subangular, round pebbles, siliceous, trace of white clay cement, white opaque altered grains, tripolitic chert, a few fractures with white, drusy, silica, crystal filling, scattered pyrite, pebbles of milky-white to gray chert, poor to fair porosity; no show.
8320-8330	Sandstone: 100%, as above, poor to fair porosity; no show.

8330-8340	Conglomerate: 100%, milky-white to gray pebbles, rounded to subangular, clear to pink, fine to coarse, sandstone matrix, siliceous, very slightly sideritic, partly quartzitic, scattered pyrite, white altered grains, tripolitic chert, fair porosity; no show.
8340-8350	Conglomerate: as above, trace dark gray pebbles, slightly sideritic, fair porosity; no show.
8350-8360	Conglomerate: 100%, as above, increasingly very coarse grained, slightly sideritic, fair porosity; no show.
8360-8370	Conglomerate: 100%, as above, abundant, very coarse grain size chert chips, angular, shattered pebbles(?), trace of very light gray, siliceous claystone with tan pellets, siderite(?); pebbles become slightly varicolored, trace of tan and light gray, subwaxy shale, slightly sandy, fair porosity; no show.
8370-8380	Conglomerate: 98%, varicolored, milky-white, clear, pink, tan with trace of dark gray pebbles, rounded to subangular pebbles, clear to red-orange, fine to very coarse sandstone matrix, siliceous, sideritic, white altered tripolitic chert grains, trace of hematite stain, fair porosity, no show; trace of red claystone, and very dark gray shale, 2%.
8380-8390	Conglomerate: 100%, as above.
8390-8400	Conglomerate: 100%, varicolored, clear, buff, pink, gray, dark gray, varicolored sandstone matrix: clear, buff, red, partly argillaceous, siliceous, partly hematite stained, rare aggregates of red and buff tabular crystals.
8400-8410	Conglomerate: 100%, as above, increasing sandstone.
8410-8420	Sandstone: 98%, varicolored, fine to very coarse, very conglomeratic, siliceous, partly argillaceous, partly hematite stained; Shale: 2%, buff, light to medium gray, micromicaceous.
8420-8430	Sandstone: 80%, very light gray-brown, mottled, fine to medium grained, subangular to subrounded, siliceous, trace white clay, white altered grains, rare pyrite, some chert granules, slightly porous; no show; Shale: 20%, dark gray, micromicaceous, slightly silty, partly very light brown-gray, light gray, papery, micaceous, partly subwaxy, rare, scattered quartz and pyrite grains; (dark brown-gray shale common, silty, trace fossil casts, cavings?); trace of red shale; shale appears to be thin interbeds.

8430-8440	Sandstone: 80%, as above; Shale: 20%, becomes partly dark gray, as above.
8440-8450	Sandstone: 85%, as above, white clay increases; Shale: 15%; no show.
8450-8460	Sandstone: 80%, salt and pepper, light gray, fine grained, subangular, siliceous, trace of white clay cement, carbonaceous, dark argillite grains, slightly porous; Shale: 20%, dark to medium gray with very light gray, papery shale; no show.
8460-8470	Sandstone: 85%, as above, partly quartzitic, increasing carbonaceous material, scattered coal grains, rare coal chips; Shale: 15%, as above.
8470-8480	Sandstone: 70%, light to medium gray, fine grained, subangular, siliceous, argillaceous, partly quartzitic, carbonaceous, coal grains, coaly partings; Shale: 30%, dark gray to very light gray, trace of light gray-green, fissile to papery.
8480-8490	Sandstone: 60%, gray, light gray, very fine to fine grained, subangular, siliceous, quartzitic in part, carbonaceous, argillaceous, shaly parting; Shale: 40%, dark gray, silty stringers, micaceous, pyritic, red and gray streaks, trace of very light gray; interbedded.
8490-8500	Sandstone: 70%, as above, becoming light tan-gray, sideritic; Shale: 30%, as above; trace of Coal: brown-black, hard, partly metamorphosed.
8500-8510	Sandstone: 80%, light brown to light gray, very fine to fine grained, subangular to subrounded, siliceous, quartzitic in part, slightly argillaceous, carbonaceous partings, partly sideritic, coal grains; Shale: 15%, dark gray, slightly brown, micaceous, pyritic; trace of red shale; Coal: 5%, black, hard, appears partly metamorphosed and shattered, probably thin stringers.
8510-8520	Sandstone: 80%, light gray, as above; Shale: 20%, as above, slightly carbonaceous, some very light gray, papery, soft.
8520-8530	Sandstone: 80%, as above, becoming gray, slightly silty; trace siltstone; Shale: 20%, as above.
8530-8540	Sandstone: 75%, gray, as above, increasing coal grains, becoming finer and less siliceous; Shale: 20%, as above, trace of green-gray, partly silty; Siltstone: 5%, gray, argillaceous, carbonaceous, slightly shaly.

8540-8550	Sandstone: 45%, light brownish-gray to gray, very fine with fine grained streaks, silty, carbonaceous, slightly siliceous, argillaceous, coal grains, partly sideritic; Siltstone: 30%, gray-brown to gray, carbonaceous, argillaceous, slightly siliceous; Shale: 25%, dark to medium gray, trace of brown and red, partly silty.
8550-8560	Sandstone: 50%; Siltstone: 30%, glauconitic, fossil fragments; Shale: 20%, as above.
8560-8570	Sandstone: 40%; Shale: 30%, trace of glauconite; Siltstone: 30%, as above.
8570-8580	Shale: 40%, as above, partly red, silty, calcareous; Sandstone: 30%, as above, with some red, very fine grained, subangular, silty, argillaceous, calcareous, conglomeratic, white-buff, and pink chert pebbles; Siltstone, 30%: as above, partly red, argillaceous, calcareous.
8580-8590	Sandstone: 95%, very light gray, pink, very fine to medium grained, subangular to subrounded, poorly sorted, very conglomeratic, varicolored pebbles, white, red, green, dark gray, very calcareous, Shale: 5%, red, as above; trace of Limestone: partly argillaceous, scattered pellets.
8590-8600	Conglomerate: 85%, varicolored pebbles, as above, light pink sandstone matrix, subangular to rounded, argillaceous; Shale: 5%, red, calcareous; Limestone: 10%, light pink, argillaceous, sandy, sucrosic.
8600-8610	Sandstone: 60%, pink to red, trace of gray, fine to coarse grained, subangular to rounded, poorly sorted, very conglomeratic, varicolored chert pebbles; red shale pebbles, pink and red limestone nodules, calcareous, slightly argillaceous; Limestone: 30%, pink to red-brown, sucrosic to cryptocrystalline, sandy, chert pebbles, argillaceous; Shale: 5%, brick red.
8610-8620	Shale: 30%, red, red-brown, calcareous, partly silty, limestone nodules; Sandstone: 15%, as above; Siltstone: 25%, medium to dark red, partly limy; Limestone: 30%, pink to red, as above.
8620-8630	Limestone: 70%, pink to red, sucrosic to cryptocrystalline, argillaceous, chert and shale pebbles, Shale: 30%, red, as above; fracture with finely crystalline calcite filling.
8630-8640	Shale: 70%, red, calcareous, partly siliceous, abundant limestone nodules, silty stringers; Limestone: 30%, as above, partly siliceous.

8640-8650	Shale: 70%, red, red-brown, trace of gray streaks, calcareous, abundant limestone nodules, silty stringers; Limestone, 30%: red, pink, sucrosic to cryptocrystalline, argillaceous, shaly inclusions, chert inclusions.
8650-8660	Limestone: 80%, as above, chert inclusions and limestone nodules, scattered sand grains; Shale: 20%, as above.
8660-8670	Limestone: 70%, as above; Shale: 40%, as above, sandy stringers;
8670-8680	Shale: 90%, red, red-brown, calcareous, abundant limestone nodules, trace of chert nodules, minor dark gray Shale: micromicaceous, moderately hard, fissile; silty stringers; Sandstone: 10%, light red, fine grained, subangular, calcareous, argillaceous.
8680-8690	Shale: 85%, red, as above, cavings(?), dark gray with light gray streaks, micromicaceous, moderately hard, fissile, slightly siliceous, trace of pyrite; Siltstone: 5%, red, calcareous, argillaceous; Sandstone: 10%, light gray, very fine to fine grained, subangular, clay cement, calcareous, glauconitic, cavings(?).
8690-8700	Sandstone: 60%, dark red-brown and shaly to light gray, very siliceous, argillaceous, coarse grained, angular, conglomeratic, slightly pyritic, pink to dark gray chert grains and pebbles, approximately 50% of grains; Shale: 40%, dark gray, as above, and red, trace only, coaly partings;
8700-8710	Sandstone: 50%, light gray, coarse grained, angular to subangular; conglomeratic, light to dark gray chert pebbles, siliceous, trace white altered grains; Shale: 40%, varicolored, red, light gray, light green, mottled, partly sandy.
8710-8720	Sandstone: 95%, light gray, trace brown mottling, clear, very conglomeratic, medium to coarse grained, subangular to angular, quartz and chert grains, siliceous, pyritic, pebbles of milky-white to very dark gray chert, streaks with good porosity; no show; Shale: 5%, as above.
8720-8730	Conglomerate: 95%; milky-white to very dark gray chert pebbles, light gray to brown sandstone matrix, siliceous, white siliceous clay and siderite cement, pyritic, good porosity, no shows; Shale: 5%.
8730-8740	Conglomerate: 95%, white with white chert and clear quartz pebbles, chert pebbles partly altered, cemented with white siliceous clay, no porosity; Shale: 5%.

8740-8750	Argillite: 95%, very dark gray, black, moderately soft to hard, fissile, quartz veinlets and fracture filling, partly carbonaceous; Coal: 5%, blocky, shiny, shattered, anthracite.
8750-8760	Argillite: 100%, as above, coaly stringers and inclusions.
8760-8770	Argillite: 100%, as above.
8770-8780	Argillite: 100%, abundant quartz veinlets, part of shale appears almost to be sandy with quartz crystals.
8780-8790	Argillite: 100%, becoming highly siliceous to sandy, sandy portion due to quartz and chert crystals.
8790-8795	Argillite: 100%, as above.

Log Analysis

ARMOUR KANE

Formation Evaluation

Well Log Analyst
18360-6 Cantara St.
Reseda, Ca. 91335
(213) 993-0586
April 28, 1977

Mr. Gordon Legg
Husky Oil/NPR Operations, Inc.
3201 C Street
Anchorage, Alaska 99503

Dear Mr. Legg:

On April 19 and 20, 1977, final log runs were made on South Simpson #1 consisting of Dual-Induction, Neutron/Density, Sonic, Dipmeter and Cement Bond Log. 18 sidewall cores were shot and 13 recovered. Quality of all logs was good except for an SP drift which necessitated a couple of manual shifts in that curve. Formation tops determined by log correlations and geologist's log were: Sag River Sand 7486, Shublik 7675, Sadlerochit 8220, Kayak 8435 (or possibly 8475) and Argillite at 8750.

Quantitative analysis figures in the Sag River and Sadlerochit are attached. Water resistivity computed from the SP in the Sag River was 0.13 while Rwa from the Sonic was 0.12, which approximates 20,000 ppm. Average porosity from the Sonic is 16.5% and 15.2% from the Density in the levels studied. Water saturations ranged from 87% to 100% with some shaliness present in the sand.

In the Sadlerochit water resistivity computed 0.12 ohms from both the SP and Sonic Rwa and water saturation ranged from 84% to 100% eliminating any possibility of hydrocarbon production. Neutron/Density cross-plots indicate the presence of some limestone content in the sands.

Very truly yours,

Armour Kane

HUSKY OIL/NPR OPERATIONS, INC. So. SIMPSON #1

SP @ 7610 = 50 MV, R_{mf} = 1.46 @ 49° @ 6400' = .52 @ 170° R_{mf}/R_w = 3.9 R_w = .133 = 20000 ppm
R_{wa} = .12

SAG RIVER SAND

(18,400)

	RT	ϕ_D	ϕ_N	ΔT	ϕ_S	R_{wa}	S_{w_a}	GR
7514	11.5	11	16	93	13	.15	89	40
7534	7	11	15	92	12.5	.13	96	38
7547	5.5	15	19	96	15	.14	93	45
7566	4	15	24	89	18	.16	89	45
7590	2.1	21	25	85	22	.13	96	32
7640-50	4	15	21	99	17.5	.13	89	46
7666	3	18	24	89	18	.12	100	45
	Av.	15.2		Av.	16.5			

SAGLEROCHIT

SP = 50 MV R_{mf} = .49 @ 184° R_{mf}/R_w = 3.8 R_w = .12 R_{wa} = .12 @ 83°F = 20,000 ppm

(19,500)

8232	18	7	8	62	8	.12	96	33
8256	20	6	7	62	8	.14	93	30
8292	5	13	19	93	16	.15	89	30
8338	10	9	10	65	10	.12	100	18
8345	15	6	8	63	8.5	.13	96	25
8362	14	7	10	65	10	.15	89	28
8396	10.5	6	10	65	10	.12	100	25
8406	7	11	13	68	12	.17	84	25
	Av.	8.2		Av.	10.2			

KEKIKTUK

8446	9	6	15	90	14	.20	89	45
8466	4	12	19	80	13	.16	100	45

SOUTH SIMPSON NO. 1
LOG ANALYSIS
BY
ARMOUR KANE(?)

SP = 40 MV RW/ = 1.54 @ 54° = .62 @ 140°

Depth	RWf/Rw = 3.1 Rt (ohms)	RW = 0.2 Δ T (Mic-Sec)	Ø %	Rwa (ohms)	Sw %
6526-28	8	87	24	.57	59
6530	5	95	30	.57	59
6534-38	15	85	22	.88	48
6540	12	74	14	.27	86
6544	13	77	16	.38	73
6546	12	85	22	.7	54
6549-51	14	75	15	.35	76
6553-56	15	78	17	.51	63
6558-64	9	87	24	.62	57
6570	20	68	9.5	.2	100

Average Ø = 19% Av. Sw = 68%

April 13, 1977

Mr. Ray Cambell
Marketing Manager
Schlumberger Well Services
Box 2175
Houston, Texas 77001

Dear Mr. Cambell:

Enclosed are prints of various logs run on Husky Oil/NPR Operations, Inc. South Simpson #1 Well on the Alaskan North Slope. The logs consist of DIL, BHC and three repeat runs of CNL/FDC and it is because of the peculiar response of the CNL/FDC through the sand at 6520 to 6600 that we send them to you in the hope that you may find an answer to the problem of a formation exhibiting a bulk density of over 3 gm/cc and a neutron porosity of 60%. Also enclosed are the sidewall core descriptions which indicate significant amounts of glauconite and hematite. The two passes of the CNL/FDC on Run #2 were made with a completely different set of down-hole tools and panels and the repeatability precludes the possibility of tool failure. Incidentally, the engineer, Earl Hosey, was most cooperative in agreeing to make the repeat runs.

This phenomenon was seen once before on the U. S. Navy's Iko Bay #1 well in 1975 and was never satisfactorily explained although I believe Bob Alger called on Mr. Hans Heiny of Tetra Tech in Houston for a discussion. In my opinion nothing could be as dense as 3 gm/cc and indicate a neutron porosity of 60% while the sonic shows Delta T values of 70-100 and R_t is not greater than 15-20 ohms. Could it be than an element is present with high gamma ray absorptive properties and highly hydrous to give these effects? I trust you will route this problem to the proper people, perhaps M. Clavier now that my old friends Bob Alger and Tixier are no longer around. Husky, the Navy and I will all appreciate an early reply.

Please give my regards to your new president and my old friend, Roy Shourd.

Very truly yours,

Armour Kane

cc: Mr. Gordon Legg
Husky Oil/NPR Operations, Inc.

Schlumberger
SCHLUMBERGER WELL SERVICES
5000 GULF FREEWAY, P.O. BOX 2175
HOUSTON, TEXAS 77001, (713) 928-2511

Eq Simpson #1

May 2, 1977

Mr. Armour Kane
18360-6 Cantara St.
Reseda, Ca. 91335

Dear Mr. Kane:

Mr. R. L. Campbell has asked me to investigate the problems described in your letter of April 15, 1977.

As you mention it, the phenomenon observed can not be attributed to logging tool failures, but its interpretation is somewhat of a puzzle. We have contacted R. P. Alger, who ran a blank when he tried to explain a similar occurrence in the U. S. Navy's well in 1975, and we have contacted C. Clavier at our Research Center.

The only two minerals we could find which exhibit at the same time a high density and a high hydrogen index are:

Daphnite (a chlorite)	ρ_g = 3.08	(HI) = 41%
Limonite (Iron Oxide)	ρ_g = 3.34	(HI) = 55%

The most likely candidate is the Limonite.

We would be very interested in knowing whether the core analysis supports our tentative answer. Please feel free to call us if you need more information.

Sincerely yours,

J. L. Dumanoir, Manager
Interpretation Development

JLD:kb

HUSKY OIL NPR OPERATIONS, INC.
U.S. GEOLOGICAL SURVEY ONPRA

HUSKY

DRILL STEM TEST REPORT FORM

WELL NAME South Simpson No. 1 DST. NO. 1 DATE 4/22/77

Formation Tested Simpson sand (Kingak Formation) Hole Size 10-3/4"

Test Interval 6522-6568', perforations D.C. Collar Length None I.D.

Total Depth 8795' (Driller) D.P. Pipe Length 6447' I.D. 4.276"

Choke Size: Surface 1/4" & 48/64" Bottom Hole 7/8" Packer Depth(s) 6447

Depth Tester Valve 6428

Cushion Type water Amount 500'

TEST DATA

Tool open at	4:43 p.m. hrs.
Initial flow period	16 min.
Initial shut-in period	31 min.
Final flow period	121 min.
Final shut-in period	236 min.
Unseated packer at	9:47 p.m. hrs.

RESISTIVITY CHLORIDE DATA

	Resistivity			Chloride Content
Recovery Water		@	°F	900 ppm
Recovery Mud	Sample chamber 1419 cc	@	°F	3000 ppm
Recovery Mud Filtrate		@	°F	ppm
Mud Pit Sample		@	°F	750 ppm
Mud Pit Sample Filtrate		@	°F	4 ppm
Mud Weight	10.5	vis	46	cp

Description of initial flow period Good to strong blow throughout. Pressure up to 20# through 1/4" bubble hose, very slight odor, questionable gas.

Description of final flow period Strong to very strong blow in 10 minutes (5:40) through 3/4" choke. Blow decreasing to strong in 30 minutes (6:00), light blow at 6:10, increasing to strong blow by 7:29 (119 minutes).

PRESSURE DATA

TEMPERATURE		Gauge No. 6141 Depth: 6484 ft.	Gauge No. Depth: ft.	Gauge No. Depth: ft.	TIME
		24 Hour Clock	Hour Clock	Hour Clock	Tool Opened A.M.
Est. °F		Blanked Off	Blanked Off	Blanked Off	Tool Opened P.M.
Actual °F		Pressures	Pressures	Pressures	Opened Bypass A.M. P.M.
		Field / Office	Field / Office	Field / Office	Reported Minutes / Computed Minutes
Initial Hydrostatic		3652			
First Period FLOW	Initial	343			
	Final	392			16
	Closed In	2331			31
Second Period FLOW	Initial	425			
	Final	604			121
	Closed In	2852			236
Third Period FLOW	Initial				
	Final				
	Closed In				
Final Hydrostatic		3586			

RECOVERY DATA

				Depth Back Pres. Valve	Surface Choke	Bottom Choke
Cushion	water	Type	Amount 500'			
Recovered	75,000 (FCPD) (est.)		Feet/bbl of			
Recovered	1215'		Feet/bbl of muddy salt water			
Recovered	500'		Feet/bbl of water cushion			
Recovered			Feet/bbl of			

Remarks Small flare of gas in 10 minutes (5:40) before water cushion to surface, changed to 1/4" choke @ 6:30 (60 min.), 3# pressure; 6:35 (65 min.), 10#; 7:00, 35#; 7:15, 45#; 7:29, 50#; Est. 75,000 CFGPD; enough to keep flare going. No hydrocarbon sheen in water, very dry gas; reversed out 1215' muddy salt water plus 500' water cushion, picked up gassy mud immediately below water cushion.

NOTE: Because of incomplete data from the field, these Drill Stem Test results have been reconstructed from field data and Halliburton reports.

Prepared by R. Brockway

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HUSKY

HUSKY OIL NPR OPERATIONS, INC.
U.S. GEOLOGICAL SURVEY/ONPRA

DRILL STEM TEST REPORT FORM

WELL NAME South Simpson No. 1 DST. NO. 2 DATE 4/24/77

Formation Tested Torok

Hole Size 10-3/4"

Test Interval 6183-6202', 6211-6220', 6231-6241' perforations

Drill Collar Length None I.D.

Total Depth 8795

Drill Pipe Length 6074 I.D. 4.276"

Choke Size: Surface 3/4" & 1/4" Bottom Hole 7/8"

Packer Depth(s) 6108

Depth Tester Valve 6088

Cushion Type Water Amount 500'

TEST DATA

Tool open at 10:38 p.m. hrs.
Initial flow period 17 min.
Initial shut-in period 29 min
Final flow period 121 min
Final shut-in period 135 min.
Unseated packer at 3:40 a.m. hrs.

RESISTIVITY CHLORIDE DATA

	Resistivity		Chlorides
Recovery Water	@ °F		
Recovery Mud Sample Chamber 2200 cc	@ °F	1100	
Recovery Mud Filtrate	@ °F		
Mud Pit Sample	@ °F		
Mud Pit Sample Filtrate	@ °F	750	

Mud Weight 10.7 vis 44

Description of initial flow period very light to light blow throughout, slight continuous increase.

Description of final flow period Light to fair blow for 21 minutes through 1/4" bubble hose, opened 1/4" choke, blow decreased to 0# @ 11:50, closed 1/4" choke, very light to light blow at end of flow test.

PRESSURE DATA

TEMPERATURE	Gauge No. 6103 Depth: 6145 ft.	Gauge No. Depth: ft.	Gauge No. Depth ft.	TIME
	48 Hour Clock	Hour Clock	Hour Clock	Tool Opened
Est. °F	Blanked Off yes	Blanked Off	Blanked Off	Opened Bypass
Actual °F	Pressures	Pressures	Pressures	Reported / Computed Minutes
	Field / Office	Field / Office	Field / Office	
Initial Hydrostatic	3433			
First Flow Initial	272			
First Flow Final	272			17
First Closed In	495			29
Second Flow Initial	272			
Second Flow Final	272			121
Second Closed In	734			135
Third Flow Initial				
Third Flow Final				
Third Closed In				
Final Hydrostatic	3433			

RECOVERY DATA

Cushion water Type Amount 500' Depth Back Pres. Valve Surface Choke Bottom Choke

Recovered 705 (12.5 bbl.) Feet xxxxx water mud (Est.)
Recovered 500 Feet xxxxx water cushion
Recovered Feet bbl of
Recovered Feet bbl of

Remarks Perforated 6183-6202', 6211-6220', 6231-6241' with 4/foot. Had trace of gas @ 600 strokes while reversing out. Took sample, recovered slightly gassy water at bottom of water cushion.

Recovered 2200 cc of slightly gassy mud with trace of oil sheen from sample chamber.

NOTE: Because of incomplete data from the field, these Drill Stem Test results have been reconstructed from field data and Halliburton reports.

R. Brockway
Prepared by

11-78

HUSKY

HUSKY OIL NPR OPERATIONS, INC.
U.S. GEOLOGICAL SURVEY ONPRA

DRILL STEM TEST REPORT FORM

WELL NAME South Simpson No. 1 DST. NO. 3 DATE 4/25/77

Formation Tested Torok

Test Interval 5807-5816', 5846-5856', 5903-5946' perforations

Total Depth 8795'

Choke Size: Surface 3/4" & 1/4" Bottom Hole 7/8"

Hole Size 10-3/4"

D.P. or Collar Length None I.D.

D.P. Pipe Length 5701 I.D. 4.276

Packer Depth(s) 5737

Depth Tester Valve 5717

Cushion Type water Amount 500'

TEST DATA

Tool open at 4:16 a.m. hrs
Initial flow period 16 min
Initial shut-in period 30 min
Final flow period 120 min.
Final shut-in period 135 min.
Unseated packer at 9:17 a.m. hrs.

RESISTIVITY CHLORIDE DATA

	Resistivity		Chlorides
Recovery Water		@ °F	950
Recovery Sample Chamber 2150 cc		@ °F	950
Recovery Mud Filtrate		@ °F	
Mud Pit Sample		@ °F	
Mud Pit Sample Filtrate		@ °F	
Mud Weight 10.7		vis 44	

Description of initial flow period light blow throughout, slight continuous increase.

Description of final flow period Light to good blow in 23 minutes (5:25), up to 5#, maintained 5# for 30 minutes (6:55), decreased to less than 3# to end of test. No gas or fluid.

PRESSURE DATA

TEMPERATURE	Gauge No 6141 Depth 5774 ft.	Gauge No. Depth ft.	Gauge No Depth ft.	TIME
	48 Hour Clock	Hour Clock	Hour Clock	Tool Opened
Est. °F	Blanked Off yes	Blanked Off	Blanked Off	Opened Bypass
Actual °F	Pressures	Pressures	Pressures	Reported / Computed Minutes
	Field / Office	Field / Office	Field / Office	
Initial Hydrostatic	4846			
Initial Flow FLOW Initial	196			
Initial Flow FLOW Final	375			16
Initial Flow Closed In	1810			30
Final Flow FLOW Initial	376			
Final Flow FLOW Final	458			120
Final Flow Closed In	1272			135
Final FLOW Initial				
Final FLOW Final				
Final Closed In				
Final Hydrostatic	4846-Q			

RECOVERY DATA

					Depth Back Pres. Valve	Surface Choke	Bottom Choke
Cushion	water	Type	Amount	500'			
Recovered	4.2		Feet/bbl of	rat hole mud			
Recovered	500'		Feet/bbl of	water cushion			
Recovered			Feet/bbl of				
Recovered			Feet/bbl of				

Remarks Perforated 5807-5816', 5846-5856', 5903-5946', with 4/foot
Took gas sample, 7 minutes before final shut-in. No odor. No analysis unless needed. Picked up gas odor 159 strokes into reversing out operations, took sample. Charts indicate perforations were beginning to plug during final flow. Did not get true formation pressures. Final closed in pressure questionable.

Recovered 2150 cc mud and one small puff of gas (50cc?) from sample chamber.

NOTE: Because of incomplete data from the field, these Drill Stem Test results have been reconstructed from field data and Halliburton reports.

R. Brockway
Prepared by

CHEMICAL & GEOLOGICAL LABORATORIES OF ALASKA, INC.

TELEPHONE (907) 279-4014 P.O. BOX 4-1276 ANCHORAGE, ALASKA 99509 4649 BUSINESS PARK BLVD.

GAS ANALYSIS REPORT

Company Husky Oil Company Date May 12, 1977 Lab. No 5785-4
Well No. South Simpson No. 1 Location
Field NPR No. 4 Formation
County Depth DST No. 1
State Alaska Sampling point before cushion, 1st initial stage
Line pressure psig; Sample pressure 10 psig; Temperature none ° F; Container number
Remarks given
Sample taken at 5:50pm (no date given)

Component	Mole % or Volume %	Gallons per MCF
Oxygen	---	
Nitrogen	87.88	
Carbon dioxide	Trace	
Hydrogen sulfide	---	
Methane	10.97	
Ethane	0.52	0.085
Propane	0.31	0.016
Iso-butane	0.05	0.035
N-butane	0.11	0.015
Iso-pentane	0.04	0.014
N-pentane	0.04	0.016
Hexanes	0.04	0.018
Heptanes & higher	0.04	
Total	100.00	0.199

GPM of pentanes & higher fraction 0.063

Gross btu cu. ft. @60° F. & 14.7 psia (dry basis) 140
Specific gravity (calculated from analysis) 0.930
Specific gravity (measured) 0.928

Remarks:

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GAS ANALYSIS REPORT

Company Husky Oil Company Date May 12, 1977 Lab. No. 5785-5
Well No. South Simpson No. 1 Location
Field NPR No. 4 Formation
County Depth DST No. 1
State Alaska Sampling point 4 minutes before final shutin
Line pressure psig; Sample pressure 50 psig; Temperature none ° F; Container number
Remarks given
Sample taken 7:25pm(no date given)

Component	Mole % or Volume %	Gallons per MCF
Oxygen	---	
Nitrogen	88.24	
Carbon dioxide	Trace	
Hydrogen sulfide	---	
Methane	10.73	
Ethane	0.51	0.069
Propane	0.25	0.013
Iso-butane	0.04	0.028
N-butane	0.09	0.011
Iso-pentane	0.03	0.011
N-pentane	0.03	0.016
Hexanes	0.04	0.018
Heptanes & higher	0.04	
Total	100.00	0.166

GPM of pentanes & higher fraction 0.056

Gross btu cu. ft. @60° F. & 14.7 psia (dry basis) 134
Specific gravity (calculated from analysis) 0.928
Specific gravity (measured) 0.928

Remarks:

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GAS ANALYSIS REPORT

Company Husky Oil Company Date May 12, 1977 Lab. No. 5785-6
Well No. South Simpson No. 1 Location
Field NPR No. 4 Formation
County Depth DST No. 2
State Alaska Sampling point 600 strokes in reversing out
Line pressure psig; Sample pressure 3 psig; Temperature none ° F; Container number
Remarks given
No sample time or date given.

Component	Mole % or Volume %	Gallons per MCF
Oxygen	---	
Nitrogen	89.40	
Carbon dioxide	Trace	
Hydrogen sulfide	---	
Methane	9.50	
Ethane	0.44	0.091
Propane	0.33	0.016
Iso-butane	0.05	0.038
N-butane	0.12	0.015
Iso-pentane	0.04	0.014
N-pentane	0.04	0.021
Hexanes	0.05	0.014
Heptanes & higher	0.03	
Total	100.00	0.209

GPM of pentanes & higher fraction 0.064

Gross btu cu. ft. @60° F. & 14.7 psia (dry basis) 125
Specific gravity (calculated from analysis) 0.935
Specific gravity (measured) 0.934

Remarks:

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GAS ANALYSIS REPORT

Company Husky Oil Company Date May 12, 1977 Lab. No. 5785-7
Well No. South Simpson No. 1 Location
Field NPR No. 4 Formation
County Depth DST No. 3
State Alaska Sampling point 159 strokes in reversing out
Line pressure psig; Sample pressure 30 psig; Temperature none given ° F; Container number
Remarks
No sample date or time given.

Component	Mole % or Volume %	Gallons per MCF
Oxygen	---	
Nitrogen	76.28	
Carbon dioxide	Trace	
Hydrogen sulfide	---	
Methane	22.21	
Ethane	0.77	0.104
Propane	0.38	0.020
Iso-butane	0.06	0.047
N-butane	0.15	0.011
Iso-pentane	0.03	0.022
N-pentane	0.06	0.012
Hexanes	0.03	0.014
Heptanes & higher	0.03	
Total	100.00	0.230

GPM of pentanes & higher fraction 0.058

Gross btu cu. ft. @60° F. & 14.7 psia (dry basis) 261
Specific gravity (calculated from analysis) 0.883
Specific gravity (measured) 0.880

Remarks:

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WATER ANALYSIS REPORT

OPERATOR Husky Oil Company
WELL NO. South Simpson #1
FIELD NPR No. 4
COUNTY
STATE Alaska

DATE May 12, 1977 LAB NO. 5785-1
LOCATION
FORMATION
INTERVAL DST No. 1(6522-68)
SAMPLE FROM Sample chamber

REMARKS & CONCLUSIONS: Mud, dark quebrach filtrate.

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	4260	185.31	Sulfate	30	0.62
Potassium	11	0.28	Chloride	4856	136.93
Calcium	38	1.90	Carbonate	180	5.99
Magnesium	Trace	0	Bicarbonate	2680	43.95
Iron	---	---	Hydroxide	---	---
Total Cations		187.49	Total Anions		187.49

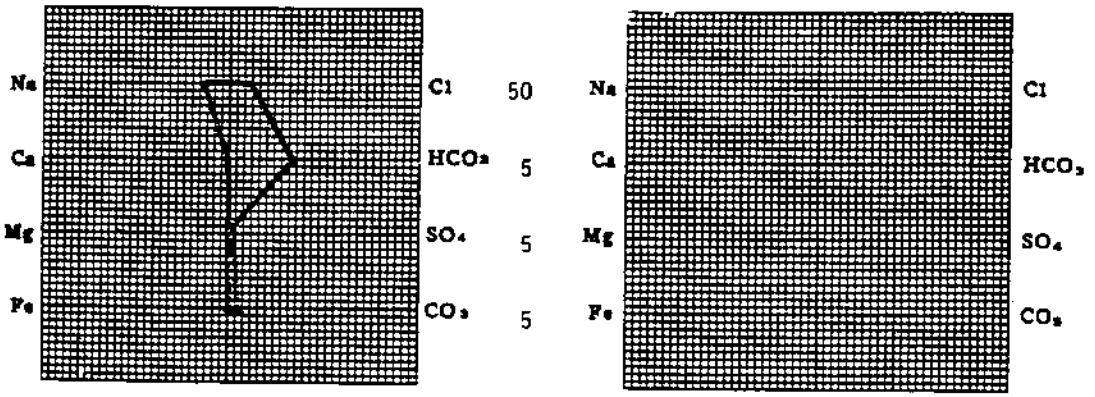
Total dissolved solids, mg/l 10695
NaCl equivalent, mg/l 10128
Observed pH 9.5

Specific resistance @ 68°F.:
Observed 0.58 ohm-meters
Calculated 0.60 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(No value is shown for ions Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Havenhorst calculation from components

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WATER ANALYSIS REPORT

OPERATOR Husky Oil Company DATE May 12, 1977 LAB NO. 5785-2
WELL NO. South Simpson No. 1 LOCATION
FIELD NPR No. 4 FORMATION
COUNTY INTERVAL DST No. 2(6183-6241)
STATE Alaska SAMPLE FROM Sample Chamber

REMARKS & CONCLUSIONS: Mud; dark quebracho filtrate

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	2963	138.89	Sulfate	37	0.77
Potassium	15	0.38	Chloride	2748	77.51
Calcium	100	4.99	Carbonate	780	25.97
Magnesium	Trace	0	Bicarbonate	1830	30.01
Iron	---	---	Hydroxide	---	---
Total Cations		134.26	Total Anions		134.26

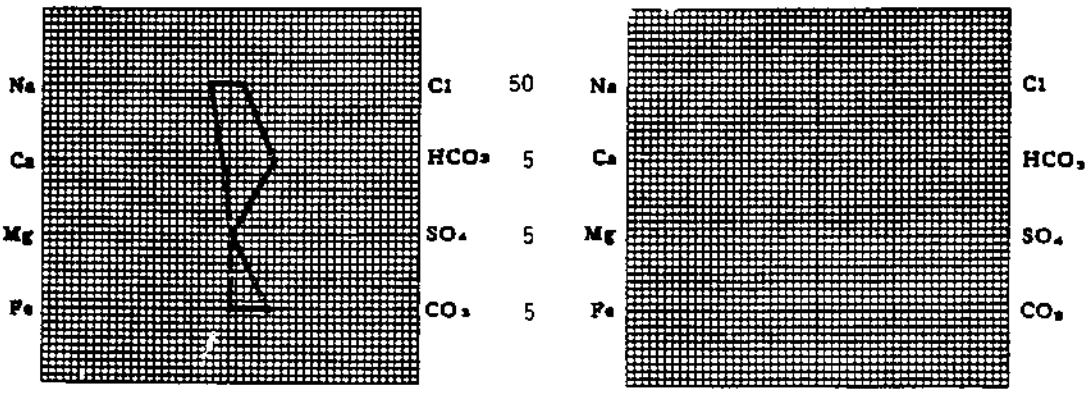
Total dissolved solids, mg/l 7544
NaCl equivalent, mg/l 7316
Observed pH 10.2

Specific resistance @ 68°F.:
Observed 0.85 ohm-meters
Calculated 0.88 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(Fe value in above cations includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Hawthorne calculation from components

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WATER ANALYSIS REPORT

OPERATOR Husky Oil Company
WELL NO. South Simpson No. 1
FIELD NPR No. 4
COUNTY
STATE Alaska

DATE May 12, 1977 LAB NO. 5785-3
LOCATION
FORMATION
INTERVAL DST No. 3(5737-6030)
SAMPLE FROM Sample chamber

REMARKS & CONCLUSIONS: Mud; dark quebracho filtrate

Cations	mg/l	meq/l	Anions	mg/l	meq/l
Sodium	1660	72.21	Sulfate	32	0.67
Potassium	56	1.43	Chloride	789	22.25
Calcium	156	7.78	Carbonate	840	27.97
Magnesium	18	1.48	Bicarbonate	1952	32.01
Iron	---	---	Hydroxide	---	---
Total Cations		82.90	Total Anions		82.90

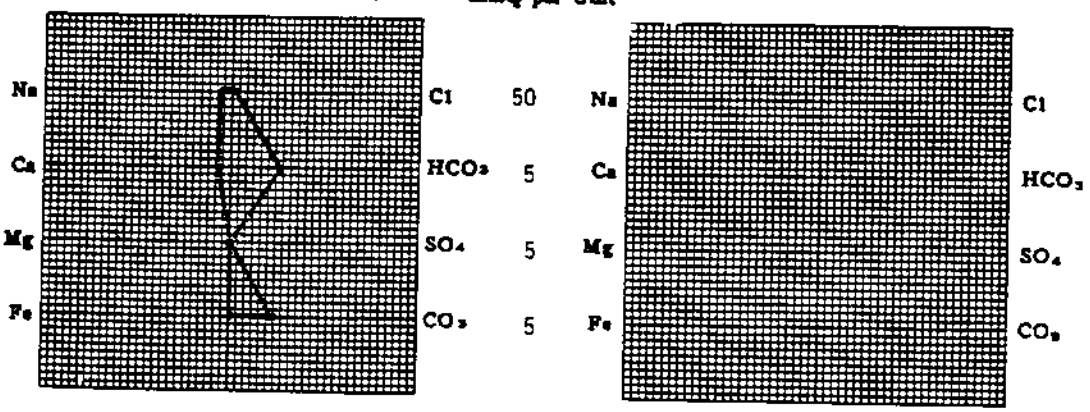
Total dissolved solids, mg/l 4512
NaCl equivalent, mg/l 4290
Observed pH 9.6

Specific resistance @ 68°F.:
Observed 1.40 ohm-meters
Calculated 1.40 ohm-meters

WATER ANALYSIS PATTERN

Sample above described

Scale
MEQ per Unit



(Na value in above graphs includes Na, K, and Li)
NOTE: Mg/l = Milligrams per liter Meq/l = Milligram equivalents per liter
Sodium chloride equivalent by Dunlap & Havenhorst calculation from components